8EHQ-1002-15166 MR 63146

Great Lakes Chemical Corporation

RECEIVED OPPT NCIC 2002 NOV -7 AM 10: 54

October 24, 2002

Contain NO CBI

TSCA 8(e) Coordinator
Document Processing Center
EPA East
Mail Stop 7407M
1201 Constitution Avenue NW
Washington DC 20460-001

RE: Follow Up to Previous Hexabromocyclododecane (CAS No: 25637-99-4) 8(e) Submission by the Bromine Science and Environmental Forum on the European Aquatic Environment

Dear TSCA 8(e) Coordinator,

Enclosed is a June 2001 report on Polybrominated Diphenylethers in the Aquatic Environment (RIVO 023/01) prepared by the Dutch Institute for Fisheries Research. This report is referenced in the RIVO C033/02 report HBCD and TBBP-A in sewage sludge, sediments and biota, including interlaboratory study, which was the source of the 8(e) information that was reported by the Bromine Science and Environment Forum (BSEF).

Please feel free to contact BSEF or me if you have questions about the work that RIVO has performed for BSEF.

8EHQ-02-15166

Sincerely,

Robert C Campbell

Robert Campbell
Director, Corp. Regulatory Affairs
Great Lakes Chemical Corp.

89030000022

RECEIVED OPPT CBIC 2002 OCT 28 AM 11: 12

Responsible Care®
A Public Commitment

C:\WINDOWS\TEMP\PBDE DeBoer June 2001 Report to EPA 8(e).doc

One Great Lakes Boulevard • P.O. Box 2200 • West Lafayette, IN 47996-2200 USA • Phone (765) 497-6100 • Fax (765) 497-6123
Email http://www.greatlakeschem.com

1R263146

Netherlands Institute for Fisheries Research (RIVO) BV

P.O. Box 68	P.O. Box 77
NL 1970 AB Ymuiden	NL 4400 AB Yerseke
The Netherlands	The Netherlands
Phone: +31 255 564646	Phone: +31 113 672300
Fax: +31 255 564644	Fax: +31 113 573477
Internet:postmaster@rivo.dlo.nl	

RIVO report

Number: C023/01

Polybrominated Diphenylethers in the Aquatic Environment

J. de Boer, J. Aldridge, C. Allchin, M. Bennett, J.P. Boon, S. Brandsma, J. van Hesselingen, R. Law, W. Lewis, S, Morris, M.R. Tjoen-A-Choy and B. Zegers

Commissioned by:	Bromine Science and Environmental Forum Burson-Marsteller Avenue de Corthenbergh 118 B-1000 Brussels Belgium
Project number:	335 76001.46
Contract number:	99019
Approved by:	dr. J.B. Luten Department Head
Signature:	______________________
Date:	29 June 2001

Number of copies:	30
Number of pages:	40
Number of tables:	10
Number of figures:	21
Number of annexes:	12

Since the first of June 1999 the foundation DLO (Agricultural Research Department) is no longer part of the Ministry of Agriculture, Nature Management and Fisheries. We are registered in trade register of the Chamber of Commerce Amsterdam nr. 34135929 VAT nr. NL 808932184B09

Table of Contents:

Annexes
1. Sample data and maps
2. WP 1 – PBDE concentrations in North Sea food chain samples
3. WP 1 – Maps with PBDE concentrations in hermit crabs and whelks
4. WP 1 – PBDE concentrations in Tees food chain samples
5. WP 1 – PBDE concentrations in Western Scheldt food chain samples
6. WP 2 – PBDE concentrations in Western Scheldt sediment, and maps
7. WP 2 – PBDE concentrations in Tees sediment, and maps
8. WP 3 – Modelling data
9. WP 4 – Sediment core dating profiles and BDE concentrations in cores
10. WP 5 – PBDE concentrations in sediments and biota (recent trend study)
11. List of scientific planned papers associated with this study
12. Method paper

Executive summary

A study was carried out on the occurrence of polybrominated diphenyl ethers in the aquatic environment. This study included the following parts: i) a study on the occurrence of PBDEs in three food chains (North Sea, river Tees (UK) and river Scheldt (The Netherlands), ii) a study on PBDE concentrations in surface sediments form the rivers Tees and (Western) Scheldt, iii) a mass balance range study in the river Tees, iv) a study on PBDE concentrations in sediment cores, v) a study on temporal trends of PBDE concentrations in sediments from UK rivers, in eel and sediments from Dutch rivers, and in cod liver from the North Sea, vi) the preparation of a scientific publication on a method for PBDEs, and vii) an international interlaboratory study on the analysis of PBDEs. The study was initiated by the Bromine Science and Envrionmental Forum (BSEF) because there was a lack of knowledge on trends on temporal trends of PBDEs in the aquatic environment, and on the behaviour of PBDEs in the food chain. Also, there was a need for harmonisation and possible standardisation of methods used for the determination of PBDEs in international laboratories. The BDEs analysed were the nos. 28, 47, 66, 71, 75, 77, 85, 99, 100, 119, 138, 153, 154, 190, and 209. The most relevant BDEs in terms of concentration appeared to be the nos. 28, 47, 99, 100, 153, 154 and, in sediments only, 209. Occasionally BDE183 was measured and found. Although some deviations from the original sampling plan had to be made due to inavailability of some species at certain locations or no permission for sampling certain bird species, the major part of the planned samples was obtained. Eight sediment cores were analysed according to plan, but some were less suitable due very slow sedimentation rates or a major disturbance of the layers. The study was carried out by the Netherlands Institute for Fisheries Research (RIVO), in partnership with the Netherlands Institute for Sea Research (NIOZ) and the UK Center for Environment, Fisheries and Aquaculture Science (CEFAS). The conclusions and recommendations of the study are given below.

Conclusions

1. In The Netherlands, the UK, Ireland, and the southern North Sea, the environmental levels of BDE congeners which can be related to the Penta-mix (BDEs 47, 99, 100) have decreased over the last decade or, at some places, have stabilised over that period. However, some exceptions, i.e. increasing trends, were found in river sediments from the Clyde, Mersey and Tyne (UK), and central North Sea cod liver. These observations need further confirmation, given the uncertainties involved in the tentative temporal trend determination.
2. The concentrations of decaBDE in surface sediments show an increase over the last six years; 50-100 % higher concentrations were found in sediment of various locations in The Netherlands, UK and Ireland over the period 1995-1999.
3. Many rivers sampled in this study showed decaBDE concentrations in surface sediments which were significantly elevated compared to background values. This was particularly true for decaBDE concentrations in the rivers (Western) Scheldt, Mersey, and Tees ($\geq$ 1 mg/kg dry weight).
4. The sediment core analyses confirm the decaBDE increase during recent years. A parallel increase of Penta-mix related congeners was not found, except in the Drammenfjord core (Norway). Therefore, and because indications of increasing nona- and octa BDEs have not been found in this study, it is unlikely that penta and hexaBDEs are being formed from decaBDE, unless at a very slow rate.
5. No measurable BDE concentrations were found in sediment cores before the early 1960s. DecaBDE concentrations in sediment cores are absent until the mid 1970s. These findings confirm the relationship between environmental levels of PBDEs and their industrial production and use, and exclude a significant natural production of PBDEs.

6. The BDEs 28, 47, 99, 100, 153 and 154 bioaccumulate through various food chains (=biomagnification). Biomagnification factors of 5-10 have been found for zooplankton to gill breathing animals and for gill breathing animals to marine mammals.
7. DecaBDE was not found in biological samples except at low levels in some common tern eggs and in some porpoise samples. The currently used analytical methods are not sensitive enough to detect decaBDE at lower levels in the food chain. The presence of decaBDE in samples from higher trophic levels shows a potential for bioaccumulation of decaBDE, but the bioaccumulation factor will be very low.
8. Penta-mix related BDE concentrations in North Sea invertebrates are higher in the west part of the North Sea, which may well be explained by transport of BDEs from dredged materials from the Tees with residual currents along the UK east coast.
9. A simple budget calculation gives an estimate of possible present day input rates from UK estuaries to the North Sea due to dredge spoil disposal to be in the range 0.03 to 0.1 tonnes/year for Σ PBDE and 0.3 to 2.0 tonnes/year for BDE209. Natural export due to tidal exchange of estuary particulates and water could lead to a similar order of magnitude of input.
10. The comparability of international laboratories for the analysis of BDE can be reflected by the following coefficients of variation (CVs): BDE47: 17-40%, BDE99: 25-77%, BDE100: 19-48%, BDE153: 30-48%, BDE154: 30-48%, BDE209: 48->100%. The international interlaboratory study organised under this project showed that high resolution mass spectrometry is not a prerequisite for producing reliable PBDE data. It should, however, be emphasized that an extensive method validation should be carried out, in particular when less selective methods are being used.
11. The methodology for the analysis for the analysis of PBDEs has been developed to a stage where it can deliver reliable results. Specialised laboratories, as the partners in this study, are now able to produce results with between-laboratory CVs of 7.5-32% for BDE47, 15-48% for BDE99, 9-21% for BDE100, 29-41% for BDE153, 13-22% for BDE 154 and 22% for BDE 209.

Recommendations

The following recommendations based on the results of this study can be made.

1. This report contains the first substantial dataset on decaBDE concentrations in the aquatic environment. In relation with a further hazard assessment of decaBDE, the increase of deca BDE concentrations in sediments should be followed closely.
2. In addition to a collection of more environmental decaBDE concentrations, more information on the aerobic and anaerobic degradation and photodegradation of decaBDE is needed to assess the risk of the presence of decaBDE in the environment.
3. The indicative HBCD concentrations found in common tern eggs, eel and other biota from the Netherlands show that this compound can readily be concentrated in biota. Its occurrence and fate merits a wider study.
4. Nona and octaBDEs, as well as BDE183 have only been studied in a qualitative way in this study and only in samples from some locations. More data on higher brominated congeners should be collected to i) obtain an impression of a possible environmental occurrence of Octa-mix related BDEs and ii) obtain more information on the eventual occurrence of octa- and nona BDEs or other degradation products which might have been formed after debromination of decaBDE.

1. Introduction

Today, 470,000 tons of bromine are produced annually, used in water purification, health care, agriculture, cars and photography (Anon., 2000). However, the most important use of bromine in in flame retardants. Flame retardants are chemicals, which added to materials, inhibit or suppress the combustion process. They interfere with combustion at various stages of the process, e.g. during heating, decomposition, ignition, or flame spread. They are being used in electronic equipment, upholstered furniture, construction materials, and textiles. Thirty-nine % of all flame retardants is based on bromine. Others contain chlorine, phosphorous, nitrogen, or are based on inorganic compounds. Brominated flame retardants are often the most effective when both performance and cost are considered. Some of the most important brominated flame retardants are: polybrominated diphenylethers (PBDEs), which can be sub-divided in PentaBDE (Penta-mix), OctaBDE (Octa-mix) and decaBDE, hexabromocyclododecane (HBCD) and tetrabromobisphenol-A (TBBP-A). The Penta-mix consists of 33.7% tetraBDE, 54.6% pentaBDE, and 11.7% hexaBDE. The Octa-mix consists of 5.5% hexaBDE, 42% heptaBDE, 36% octaBDE, 13.9% nonaBDE, and 2.1% decaBDE. DecaBDE consists of 3%nonaBDE and 97% decaBDE (Spiegelstein, 2000). PentaBDE is only used in flexible polyurethane foam and upholstery textile in furniture. OctaBDE and decaBDE are mainly used in plastic housings and smaller components (office equipment and TV backcasings). DecaBDE is also used in upholstery textiles (latex backbones), but not in clothing. TBBP-A is mainly used in printed circuit boards in PC and plastic housing (office equipment, TV backcasings). HBCD is used in articles made of polystyrene and in textile backcoating for the EU market. End products include upholstered furniture, interior textiles, automobile interior textiles, car cushions, insulation blocks in trucks and caravans, building materials, such as house walls, cellars, roofs parking decks and, packaging materials, video cassette recorder housing and electric equipment (de Wit, 2000). The total market demand for brominated flame retardants by regions is shown in Table 1.1. At 30 January 2001, the European Commission has issued a proposal to ban the production and use of PentaBDE.

Table 1.1. Major brominated flame retardants volume estimates – Total market demand by region in 1999.

Flame retardant	Europe	Americas	Asia	Total
TBBP-A	13,800	21,600	85,900	121,300
HBCD	8,900	3,100	3,900	15,900
DecaBDE	7,500	24,300	23,300	54,800
OctaBDE	450	1,375	2,000	3,825
PentaBDE	210	8,290	-	8,500
Total	30,860	58,665	114,800	204,325
Percentage	15.1	28.7	56.2	100

PBDEs have been detected in the environment since the 1980s (Andersson and Blomqvist, 1981, Wolf and Rimkus, 1985, de Boer, 1990, Sellström et al., 1990, Pijnenburg et al., 1995). More recently, more attention is given in the scientific literature to the environmental occurrence of PBDEs. PBDEs were found to be present in sperm whales which is an indication for the presence of these compounds in deeper waters of the ocean (de Boer et al., 1998). Subsequently, PBDEs have been detected in a wider range of pelagic marine mammal species which feed over the outer areas of the continental shelf, the continental slope, and in deep offshore waters, including a Sowerby's beaked whale and two mysticete species, the fin and minke whales (Law et al., 2000). PBDEs were also found in relatively high concentrations in marine mammals from the North Sea (de Boer et al., 1998, van Bavel et al., 1998). In addition to that, increasing trends of PBDE concentrations in Swedish human milk were presented at the Dioxin 98 symposium in Stockholm (Meyronité et al., 1998, Norén and Meyronité, 1998). The PBDE patterns observed in human milk and in marine mammals and fish mainly consist of 2,4,2',4'-tetra BDE (BDE47) together with smaller amounts of some other tetra, penta and hexa BDEs. PBDEs were also found in several estuaries in Europe, among which those of the rivers Scheldt in The Netherlands and Mersey and Tees in the UK (Anon., 1997, Allchin et al., 1999). In these rivers also relatively high levels (up to mg/kg dry weight) decaBDE were found. DecaBDE shows the highest production volumes of all PBDEs. Lower amounts of the so-called 'Penta-mix' have been produced, but its production figures have decreased over the last decade. The decaBDE is mainly used is plastic housing of TV sets and personal computers, whereas the Penta-mix is mainly used in foams such as are used in car seats and furniture. The amounts of Penta-mix produced in the past seem to be insufficient to explain the environmental concentrations. Natural production of hydroxylated PBDEs has been reported (Gribble, 1998, 1999, 2000), but it is unlikely that pure PBDEs can be produced by marine organisms.

The gap of knowledge in the information on the production and environmental levels of PBDEs required further research on the environmental occurrence of PBDEs. This report includes the results of a study based on the objectives described below. The main body of the report includes summary tables and figures that are of immediate relevance to the reader, and the associated text on the results and discussion, as well as conclusions and recommendation. All details, including all concentrations measured, cofactors, additional figures, etc. have been included in a series of annexes, which are added at the end of this report.

2. Objectives

The objectives of this study can be summarised as follows:
1. To study the uptake of PBDEs in aquatic food chains and to assess if, and to what extent, PBDEs and in particular higher brominated PBDEs can be accumulated in these food chains.
2. To study the occurrence of PBDEs in sediments from estuaries to assess which PBDEs are present in these sediments.
3. To make a first rough estimation of the relation between the PBDE levels found in the food chain and the sediments mentioned under 1 and 2, respectively, and the production figures of PBDEs (mass balance range).
4. To analyse eight sediment cores in order to assess the occurrence of PBDEs in older sediment layers, this to assess if PBDEs were maybe already present before the industrial production of these compounds had started.
5. To analyse a number of recent environmental samples to establish the most recent trends in PBDE contamination.
6. To write a scientific paper on analytical methods for the determination of PBDEs and publish this in a high quality international peer-reviewed scientific journal.
7. To organise an international interlaboratory study on the analysis of PBDEs to assess the comparability of the performance of laboratories for this analysis.

3. Methods and materials

3.1 Analytical methods

The following PBDE congeners have been analysed during this study:

Systematic nr.	Structure (Sjödin et al., 1998)
28	2,4,4'-tri
47	2,4,2',4'tetra
66	2,4,3',4'tetra
71	2,6,3',4'tetra
75	2,4,6,4'tetra
77	3,4,3',4'tetra
85	2,3,4,2',4'penta
99	2,4,5,2',4'penta
100	2,4,6,2',4'penta
119	2,4,6,3',4'penta
138	2,3,4,2',4',5'hexa
153	2,4,5,2',4',5'hexa
154	2,4,5,2',4',6'hexa
190	2,3,4,5,6,3',4'hepta
209	2,3,4,5,6,2',3',4',5',6'deca

In addition, BDE183, 2,3,4,6,2',4',5-heptaBDE has been included in some analyses. Also, total hexabromocyclododecane (HBCD) has been analysed in a number of samples. The results for that compound should be considered as indicative, as the method was still under development. However, given the production figures of HBCD and its environmental presence, it was considered of importance to include indicative data of HBCD in this study.
The three institutes involved in this study, RIVO (Netherlands Institute for Fisheries Research, IJmuiden, Netherlands), NIOZ (Netherlands Institute for Sea Research, Den Burg, Texel, Netherlands) and CEFAS (Center for Fisheries and Agricultural Sciences, Burnham on Crouch, UK) all used gas chromatography with mass spectrometric detection, using negative chemical ionisation as the ionisation method (GC/NCI-MS). The instrument type used at all three institutes was an Agilent 5973/6890. CEFAS has used GC/ECD for a number of decaBDE analyses, due to instrumental difficulties with the GC/MS combination. Extraction and clean-up methods were different, as well as the type of GC columns used. RIVO and CEFAS used two different columns for the analysis of decaBDE (short column) and the remaining BDEs (longer column). NIOZ had decided to combine the analysis of all BDE congeners at one 25 m column. A summary of the methods is given in Table 3.1. Details are described in the analytical method paper produced under Work package 6 (Annex 12). Interlaboratory tests were carried out to study and improve where necessary the mutual comparability of the three laboratories. Details can also be obtained from the report on the interlaboratory study in which these laboratories had the following participant codes: RIVO: 12, NIOZ: 11, CEFAS: 19. At the time of the project, none of the institutes was accredited for this type of analysis, but RIVO recently received accreditation for the PBDE analysis.

Table 3.1. Analytical methods used for this study.

	RIVO	NIOZ	CEFAS
Extraction (biota)	Soxhlet	Ultra Turrax*	Soxhlet
Solvents (biota)	Hexane/acetone (3:1, v/v)	Acetone/pentane/ water (1:1:1, v/v/v)	Hexane/acetone (1:1, v/v)
Extraction (sediment)	Soxhlet	Shaking	Soxhlet
Solvents (sediment)	Hexane/acetone (3:1, v/v)	Acetone/pentane (1:1, v/v)	Hexane/acetone (1:1, v/v)
Sulphur removal	GPC	Na_2SO_3, H_2SO_4	copper
Fat separation	GPC	H_2SO_4	GPC
Further clean-up	Silica and H_2SO_4	Silica	Silica
Internal standard	CB112	CB 112, BB209	CB198
GC column 1	CP Sil 8	CP Sil 8	DB-5
Dimensions	50m-0.21mm-0.25µm	25m-025mm-0.25 µm	50m-0.25mm-0.25µm
Injector temp. (°C)	275	275	50
Max. oven temp.(°C)	315	320	275
Injection technique	Pulsed splitless	Pulsed splitless	PTV*
GC col.2 (BDE209)	DB-5	-	HP-1
Dimensions	15m-0.25mm-0.25µm		15m-0.25mm-0.1µm
Injector temp. (°C)	275		70*
Max. oven temp.(°C)	300		295
Injection technique	Pulsed splitless		Pulsed splitless
Detection technique	NCI-MS	NCI-MS	ECD for BDE209 NCI-MS for other BDE congeners
Quantification	Area	Height	Height
Scanned ions	79, 81; HBCD: 158, 160; BDE209: 486.7, 488.7	79, 81; BDE209: 486.7	79, 81

* PTV conditions: Initial temp.: 70°C, initial time: 0.3 min, ramp at 720°C/min to 450°C, final time: 5 min, vent time: 0.2 min, vent flow:
100 ml/min, purge flow: 500 ml/min, purge time: 3 min.

3.2 Materials

Figures 3.1and 3.2 show maps of The Netherlands and the UK, respectively, at which the rivers where the sampling took place have been indicated. Annex 7 includes two maps with sample locations in the river Tees (UK) (WP 2). Details of the North Sea sampling for work package (WP 1) are shown in Annex 1.
In a large field sampling programme such as the one for this study, it is natural that the final collection of samples is somewhat different from the orginal plan. This is due to various reasons, such as changes in populations with time, weather conditions, occurrence of some species only in specific and variable periods and others. Overall a good coverage of the sampling plan as designed in the contract was obtained. Difficulties in sampling of the following organisms were in particular encountered for WP 1: Sprat was not obtained from the North Sea (WP 1), the number of North Sea shrimp samples was limited to two, hermit crab, arenicola marina and cod could not be obtained from the Tees estuary, while the number of sprat samples was limited to two. A license for sampling terns could not be obtained both for the Tees and the Western Scheldt, and the number of Eurythemora samples from the Western Scheldt was limited to one. It should be noted that it is exceptionally difficult to obtain suitable samples of material for contaminant studies from the inner Tees estuary and the sample numbers here are small. On the contrary, a considerable number of extra samples was taken, resulting in the overview in Table 3.2. All relevant sample parameters are given in Annex 1.
In WP 2 nineteen surface sediment samples were taken in the Western Scheldt and 50 samples were taken in the river Tees, which is far above the original plan. The surface sediment samples from The Netherlands (WPs 2 and 5) were taken by a Van Veen grab,at dry parts during low tide (Western Scheldt) or from a small boat at the river (Rhine delta, Meuse, and Liffey, Ireland).

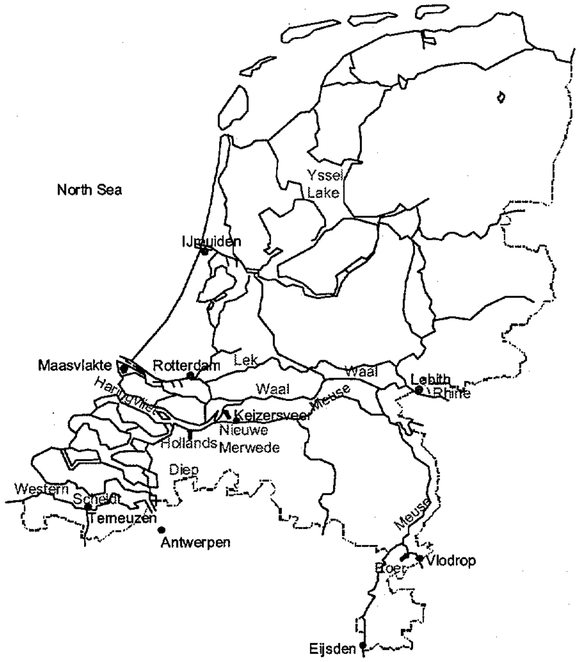


Figure 3.1. Sampling locations in The Netherlands

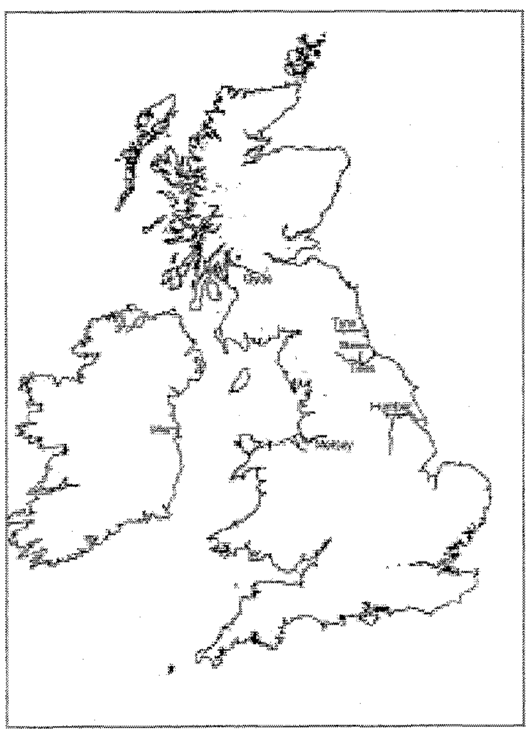


Figure 3.2. Sampling locations in the UK

Table 3.2. Overview of samples used for WP 1

Species	North Sea	Tees	Western Scheldt
Copepods			1
Praunus			1
Mysid shrimp			9
Shrimp	2	2	
Nereis		1	
Whelk	6		
Hermit crab	9		
Starfish	7	1	
Gudgeon			6
Greater sandeel			3
Herring	4 fillet, 2 milt, 2 eggs		
Whiting	6 fillet, 6 liver	12 fillet, 10 liver	
Cod	7 fillet, 6 liver		
Harbour porpoise	9 blubber, 6 liver	28	
Seal	9 blubber, 6 liver		
Dolphin	11**		
Common tern egg			30*
Cormorant liver		47	

* 15 from the Western Scheldt, 15 from a reference location at the Maasvlakte; ** 7 Whitebeaked dolphins and 4 Bottlenose dolphins.

The UK samples were taken by a modified Day grab. Sediment samples were composed by pooling nine grab samples from an area of 100 m^2 per location. Dry weights and total organic carbon (TOC) contents were determined in all samples and can be found in the annexes associated with the respective WPs. In most UK sediment samples, a particle size distribution was determined in addition to the TOC. This was done because along the UK east coast high concentrations of coal particles are being found in river sediments. These small coal particles hinder a proper normalisation of contaminant concentrations in the sediments, because the total weight of these particles in too high in relation with the available surface for adsorption. Therefore, the normalisation of PBDE concentrations in these samples was done by using these particle size distribution figures.
Nine sediment cores have been analysed, which is one more than originally planned. However, not all locations mentioned in the original plan were suitable for analysis on PBDEs. Some cores appeared to be taken for geochemistry reasons only, which meant that the top layer could not be split into layers associated with periods of ca. 5-10 years, but only covered periods of ages or more. The following cores were analysed: Vlieter (Wadden Sea, The Netherlands), Drammenfjord (Oslofjord, Norway), Lake Woserin, (east) Germany, Skagerak (Denmark), Meerfelder Maar (Eifel, Germany), Birkat Ram (Israel), German Bight (North Sea, Germany), Saanich Inlet (Vancouver, Canada), and Kimmeridge Clay Formation (Swanworth Quarry, Dorset, UK). The latter two were also very old cores, 400 and 150-200 million years old, respectively, and were only analysed for one layer to determine if PBDEs could be associated with natural production. The dating profiles of five cores, for which the dating was carried out at NIOZ, are shown in Annex 9.
All samples for WP 5 (recent trend study) could be taken according to plan. Details are given in Annex 1.

4. Work package 1 - Food chains

The study on the food chains was focused on the bioaccumulation of in particular higher brominated diphenylethers through various food chains (=biomagnification). For that purpose three food chains were selected to be studied: i) a food chain from the North Sea, comprising benthic invertebrates (seastars, whelks, hermit crabs and shrimps), pelagic fish (feeding on zooplankton) (herring), demersal fish (whiting and cod), and marine mammals (seals and cetceans, ii) a food chain comprising benthic organisms (nereis, asterias, shrimp), pelagic fish (sprat), demersal fish (whiting), marine mammals (porpoises) and birds (cormorants) from the Tees estuary, UK, and iii) a food chain comprising zooplankton (copepods and mysid shrimps), small fishes (gudgeon and greater sandeel) and bird eggs (common tern eggs) from the Western Scheldt, The Netherlands. The results of the three studies are presented below.

4.1 North Sea food chain

All samples analysed and the corresponding results are given in Annex 2. Sample data can be found in Annex 1.

The advantage of invertebrates over higher organisms as fish and marine mammals is, that they are much less migratory and are thus more representative for the situation at the site of capture. Because the hard parts of starfishes and hermit crabs are difficult to homogenise, we selected specific tissues for analysis. Of the starfish, the pyloric caeca were chosen. These are parts of the digestive system located pair-wise in each of the five arms of a starfish. Of the hermit crabs, the entire abdomen was taken. This asymmetrical anterior part of the anomal holds the shell serving as the house of the crab. It contains muscle tissue, part of the digestive system (liver, gut), and gonads. No differentiation was made between the sexes during sampling. Of the whelks only the male whelks were used, they were taken out of their shell and the entire soft parts of the animals were used. Shrimps were sampled on two locations, the animals were pealed prior to extraction and the whole soft parts are used. The levels of the PBDEs are expressed on a lipid weight basis. From previous work with organochlorines (PCBs, DDTs etc.) we have experienced that the levels of anthropogenic compounds are highly similar between different organs of the same animal after a correction for differences in lipid contents has been made.

In Annex 3 overviews are given of the PBDE concentrations found in starfish, hermit crab and whelk connected to the locations where they were obtained. In general it can be said that the geographical trend is highly similar in all species, the concentrations of BDEs in the abdomens of hermit crabs being slightly above those in the pyloric caeca of starfishes and the whelks. The levels found for the shrimps are corresponding with the levels of the other invertebrates measured at the same locations.

The pattern of the BDEs in these animals shows that BDE47 is usually present in the highest concentrations, followed by the BDEs 99 and 100, and the BDEs 153 and 154. BDE209 is either present below or just above the detection limit. However, since both our samplings either were a part of the digestive system (starfish) or contained parts of the digestive system (hermit crab, whelk, shrimps), we do not see the levels BDE209 above the detection limit as an unambiguous proof for uptake by the organism. Instead, these levels may represent remainders of food including small sediment particles present in the gut.

Geographically, there are considerable differences in the North Sea: the highest levels occur near the English coast, especially near the estuaries of the rivers Tyne and Tees, but also further south. Residual currents in the area of the rivers Tyne and Tees run south along the English coast and then turn eastward near Flamborough head, transporting water and suspended particles in the direction of the Dogger

bank in the central North Sea. In contrast, surprisingly low levels were found along the coasts of continental Europe, showing that the major rivers there (Rhine, Meuse, Elbe) may not be major sources of PBDEs for the North Sea ecosystem. The number of samples taken along the continental coast was, however, relatively small. A confirmation of this observation is required. In the Skagerak, the levels seem to increase from west to east, representing an increasing influence of water from the Baltic, which is known to contain elevated levels of BDEs from previous Scandinavian studies (Haglund et al., 1997, Sellström et al., 1996).
PBDEs in fish were measured in two tissues: the liver and the fillet (muscle tissue). Herring eggs and milt have also been obtained and measured. The levels in the herring liver and fillet samples almost the same, while for the cod and whiting the levels are somewhat higher in the liver tissue than in the fillet. The PBDE concentrations in herring fillet and liver are, on a lipid weight basis, somewhat higher than in milt and eggs.
The levels found in cod are higher than those found in herring. The variation between the six locations investigated is not very large; only one station is twice as high as the other stations. PBDE concentrations in whiting vary much more than in cod, from a total of about 20 to about 200 ng/g lipid.
The concentrations found for the different stations do not correspond with the trends found for the invertebrates. This is clearly due to the fact that the fish does not stay at one location but migrate freely throughout the North Sea.
The PBDE concentrations in the marine mammals are up to 10-fold higher than for the fish and invertebrates. PBDE concentrations in most porpoises are around 1500 ng/g lipid. Two exceptions are one foetus with a very low level and one immature female which has a PBDE level of about 10,000 ng/g lipid in herring liver. There are two seals with rather high PBDE concentrations of about 4,000 and 10,000 ng/g lipid whereas the other animals have PBDE concentrations of ca. 750 ng/g lipid. From one white-beaked dolphin several tissues have been analysed. The PBDE concentrations expressed in the amount per g lipid is the same for all tissues, apart from the brain tissue with levels 5-fold lower than in the other tissues. The PBDE concentration found in this dolphin was 40,000 ng/g lipid. The PBDE concentrations found for another whitebeaked dolphin are much lower with ca. 600 ng/g lipid. The concentrations found in the bottlenose dolphin, are about 2,000 ng/g lipid. For this animal four different types of tissue were measured, all showing similar PBDE concentrations.

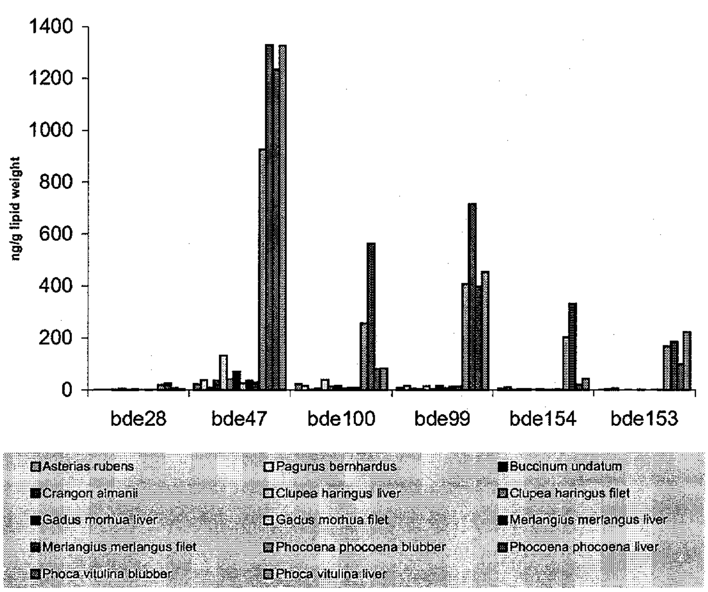


Fig. 4.1. BDE concentrations in biota.

In all biota analysed BDE 47 is the principal congener except for the starfish in which BDE 100 is higher (Figs. 4.1-4.2). It can be seen that in invertebrates the amount of BDE 47 is less than 50 percent except for the shrimps while in fish it is always higher than 50 percent. In the harbour porpoise the level for BDE 47 is less than 50 percent and for the harbour seal it is higher than 50 percent. BDE 100 and 99 are the other important congeners present in biota and for the vertebrates these are the largest compounds after BDE 47. The only exception is the harbour seal in which BDE 153 is higher than the remarkably low amount of BDE 100.

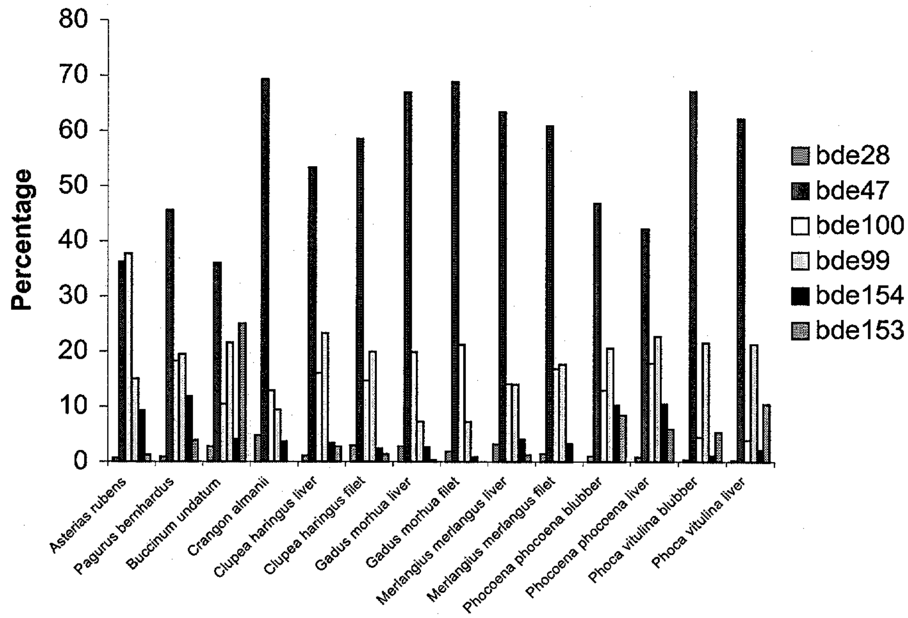


Fig. 4.2. The percentages of the different BDE present in biota.

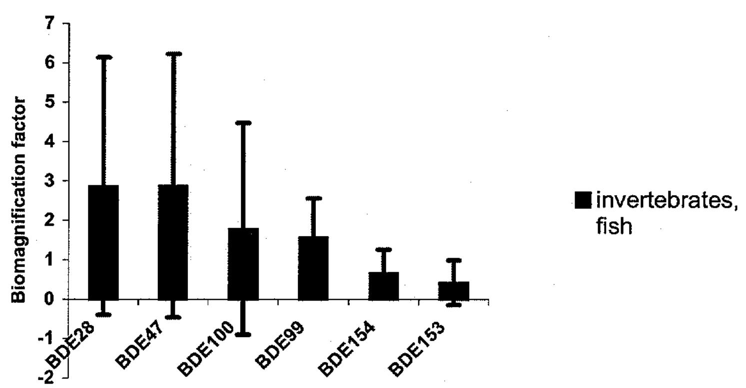


Fig. 4.3. The biomagnification factors (with error bars) for invertebrates (starfish, hermit crabs, whelks and shrimps) to fish (herring, cod and whiting).

In Fig. 4.3 the biomagnification factors for invertebrates to fish are shown. The biomagnification factors seem to be in between 0 and 5 for all compounds.

Going from the fish to harbour porpoises the biomagnification factors are much larger (Fig. 4.4). There has been made a selection of the harbour porpoises measured in order to lower the variation in the amounts detected.

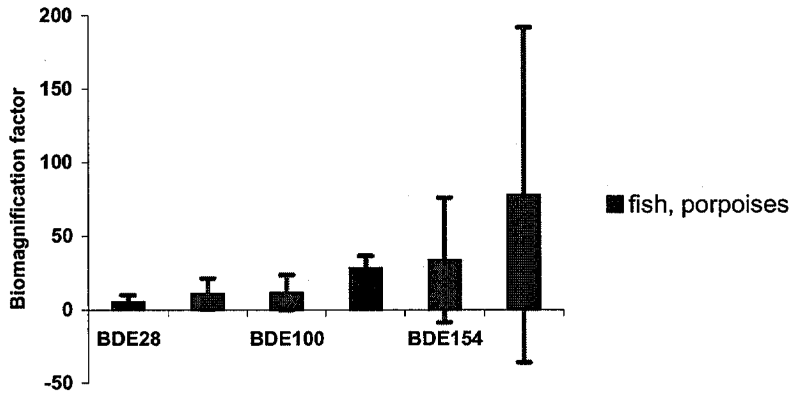


Fig. 4.4. Biomagnification factors (with error bars) for fish (herring, cod and whiting) to harbour porpoises.

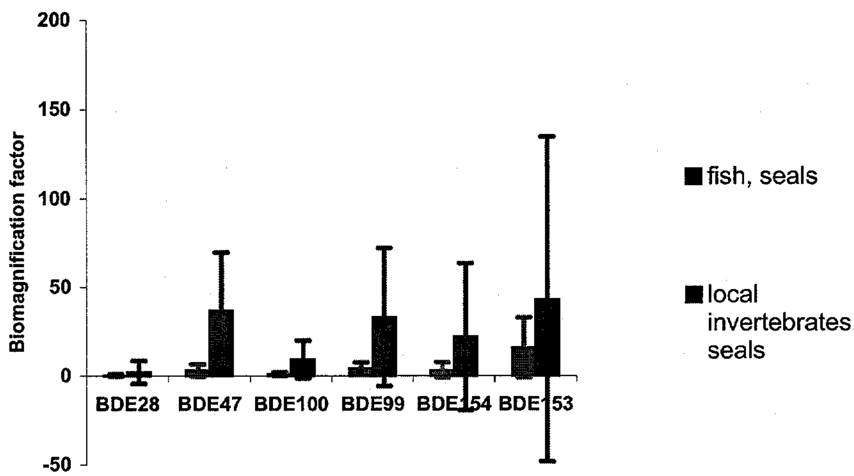


Fig. 4.5. Biomagnification factors (with error bars) for fish (herring, cod and whiting) to harbour seals and for local invertebrates to harbour porpoises.

Even then the variations found in these biomagnification factors are relatively large but the factors calculated are much higher than those found upon going from invertebrates to fish. There seems also be a trend to higher biomagnification factors for the higher brominated compounds.
The harbour seals studied all come from the Wadden Sea. It can therefore be discussed if the amounts of the BDE present in fish should be taken or if the amounts of BDE present in the local occurring invertebrates are a better indication for the intake of BDE by the seals. This can be done as the biomagnification from invertebrates to fish seems to be very little. In Fig. 4.5 the biomagnification factors

are calculated in both ways, and it can be seen that there are considerable differences in the results. Remarkable is the lower biomagnification factor found for BDE100 which can be possibly related to the increased metabolism in harbour seals in respect to harbour porpoise in which the biomagnification factor of BDE47 seems to be the same as for BDE100. For the other compounds it can be seen that calculation of the biomagnification factors for the seal via the levels of BDE in locally present invertebrates obtains comparable biomagnification levels with the harbour porpoises which can be expected as they are at the same trophic level.

4.2 Tees food chain

4.2.1 Cormorants

All samples analysed and the corresponding results are given in the Annexes 4.11-4.16. With the legal problems associated with the provision of samples of terns due to their protected status, cormorant (*Phalocrocorax carbo*) liver samples were substituted. Fourty seven samples of liver were obtained from cormorants shot under licence during investigations into the impact of piscivorous birds on freshwater fisheries in England. The cormorants were sampled during the 1996-7 and 1999-2000 winter periods (October to March).
The sex, age, date shot and location of samples are given in the Annexes 1.6 and 1.7. Cormorants were not all from the Tees areas, but were obtained from a relatively large area in the UK. They can migrate over considerable distances. Summed concentrations of the 14 congeners determined (S14BDE) ranged from 1.8 to 140 µg/kg wet weight in cormorant livers (Figure 4.6). The most abundant congeners were generally BDE47, BDE99 and BDE100. BDE47 contributed 24-100% in cormorants. The highest S14BDE concentrations were found in an immature female cormorant shot in Hampshire (140 µg/kg), an adult male from Monmouthshire (128 µg/kg), an immature male from Hampshire (115 µg/kg), and an adult male from Surrey (60 µg/kg) (Figure 4.7). BDE209 was not found in any of the cormorant samples examined. Congener profiles and concentrations were similar in both male and females birds. The concentrations in the males were generally higher than the female birds, but this is not thought to be significant given the variations in the sampling programme.

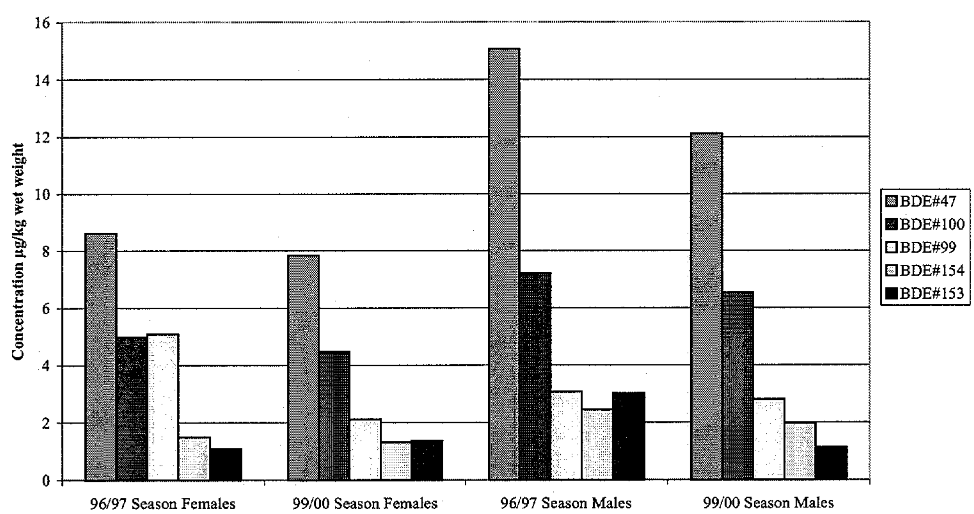


Figure 4.6. PBDE concentrations in cormorant liver.

Cormorants are common on European coasts and increasingly inland throughout the temperate and sub-arctic waters of the Northern Hemisphere. Despite this, very few comparative data are available in the literature. One cormorant sampled in the Rhine delta in the Netherlands in 1981 yielded liver concentrations of 25,000 and 4,000 µg/kg wet weight of BDE47 and BDE99 respectively, both more than two orders of magnitude higher than the highest values for these congeners observed in this study (de Boer, 1990).

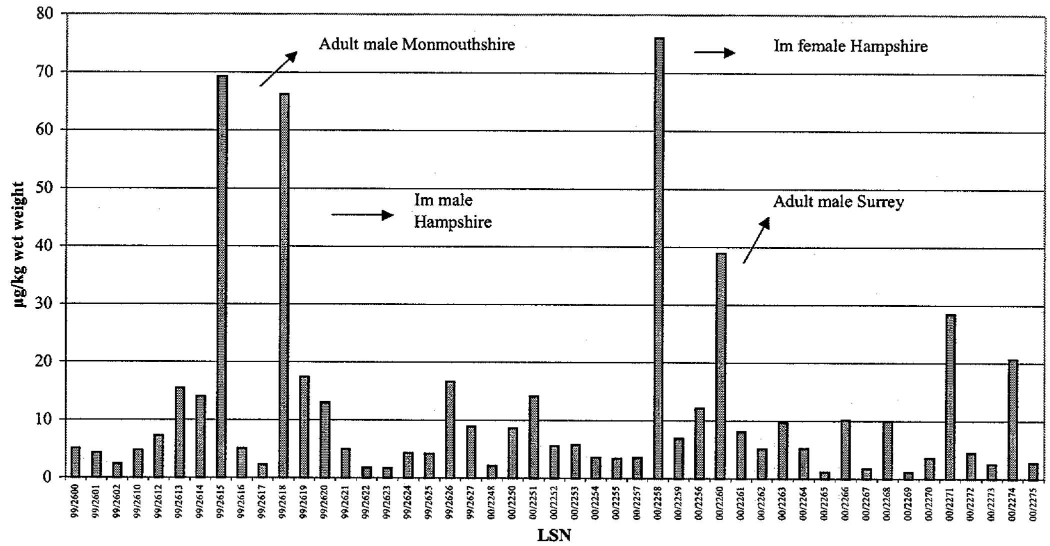


Figure 4.7. BDE47 concentrations in cormorant livers.

4.2.2 Porpoises

Twenty eight samples of blubber from harbour porpoises (*Phocoena phocoena*) were derived from the UK national marine stranding programme funded by the UK government, and operated by the Natural History Museum and the Institute of Zoology. The sample locations ranged from Berwick on Tweed to Lowestoft. The results of the porpoises are given in the Annexes 4.3-4.6. BDE47 contributed 39-88% of S14BDE in porpoises. Summed concentrations of the 14 congeners determined (S14BDE) ranged from 370 to 6,900 µg/kg wet weight in porpoise blubber, with little variation between males and females. The highest value was found in an animal from the Tyne/Tees area. The concentrations of BDE47 and S14BDE in the blubber of this porpoise were 6,110 and 6,900 µg/kg wet weight (6,800 and 7,670 µg/kg on a lipid weight basis), respectively. Similar concentrations have been reported for a single white-beaked dolphin (*Lagenorhyncus albirostris*) stranded on the Dutch coast of the North Sea, in which the concentrations of BDE47 and S3BDE (congeners BDE47, 99 and 100) were 5,500 and 7,700 µg/kg wet weight (de Boer et al., 1998).
Similar sum of 19 BDE congeners concentrations in male and female pilot whales from the Faroe Islands have also been reported (Lindstrøm et al., 1999). In this study higher concentrations were found in young specimens of both sexes than in adults, which the authors ascribed to lactational transfer of PBDEs during suckling of youngs. The summed concentrations in five pooled pilot whale blubber samples in that study ranged from 690 to 2,400 µg/kg wet weight (840 - 3,160 g/kg on a lipid basis). Study of PBDEs in the blubber of beluga whales from Arctic Canada have demonstrated an increasing trend in concentration over the period 1982 - 1997,

reflecting the increase in industrial use of these compounds over that period (Stern and Ikonomou, 2000). These data also provide some evidence that PBDEs can be transferred from temperate latitudes to the Arctic as a result of long-range atmospheric transport, in the same way as organochlorine compounds (sometimes referred to as "global distillation") (Goldberg, 1975, Loganathan and Kannan, 1994). PBDE concentrations were generally much higher in porpoise blubber than cormorant liver, and given the relative size of these tissues in the two species the body burdens of the porpoises would be far in excess of those in the cormorants.

4.2.3 Fish and benthic organisms

Samples of whiting (bulked liver and bulked muscle), sprats (whole) and flounder liver were taken from the Tees estuary and Tees Bay. Limited samples of crangon sp., nereis sp. and asterias were also collected.These data are presented in the Annexes 4.1-4.2 and 4.7-4.10.
PBDEs were found in all samples of biota ranging from 2.7 µg/kg (sum BDE) in crangon to 19 µg/kg in asterias wet weight (Figure 4.8). Interestingly there were differences in the PBDE profiles between species. The dominant congener in crangon was BDE99 followed by BDE47 and BDE71, in nereis the dominant congener was also BDE99 followed by BDE47. The profiles of asterias, whiting, sprat and flounder were more typical of those seen in biota with BDE47, 100 and 99 dominating. The differing profiles of crangon and nereis maybe a function of their position in the marine food chain. Crangon is generally a planktonic feeder although can also feed by grazing on surface sediment. Nereis is a carnivorous worm but does burrow and therefore exposure to PBDEs will be by direct contact with contaminated sediment as well as through the diet.

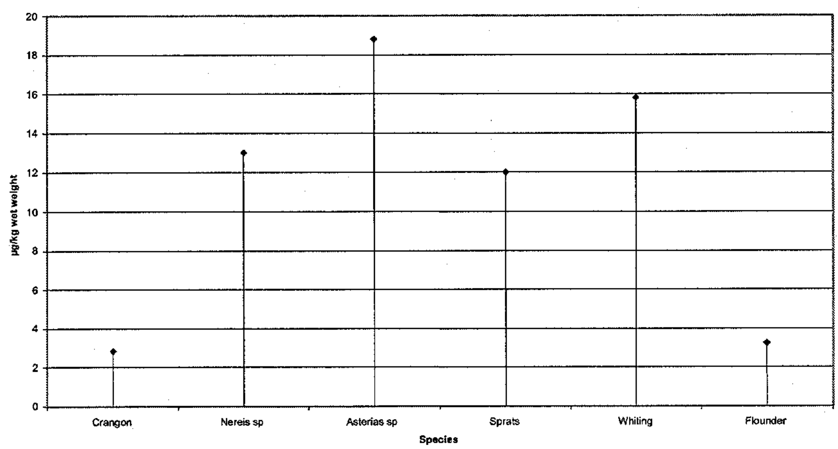


Figure 4.8.Total PBDE concentrations in biota from the Tees.

Asterais will feed largely on bivalve molluscs, which although examined in this study are known to have profiles dominated by BDE47.
It is worth noting that BDE209 was not found in any samples of biota from the Tees area.

4.3 Western Scheldt food chain

All samples analysed and the corresponding results are given in Annex 5. Figures 4.7-4.9 shows the biomagnification factors found for the prevailing BDEs. A summary of the concentrations found on a lipid weight basis is given in Table 4.1.
A clear biomagnification is found for the BDEs as for HBCD from lower organisms such as mysid shrimp and copepods to gudgeon (Figure 4.7). However, a biomagnification of BDEs from gudgeon to common tern eggs was not found (Figure 18). A biomagnification from lower organisms to in greater sandeel was not found. Also, no biomagnification was found for greater sandeel to common tern eggs. The biomagnification factor (BMF) for mysid shrimp to gudgeon is ca. 10-12, for HBCD this BMF is 3-5 for the same species. BDE 153 showed a deviating behaviour with larger BMFs than for the other BDEs (Figure 4.8). The biomagnification found for BDE 47 was not higher than for the penta BDEs, and only slightly higher than for the hexa's. It is unclear why the biomagnification from gudgeon to common tern eggs is

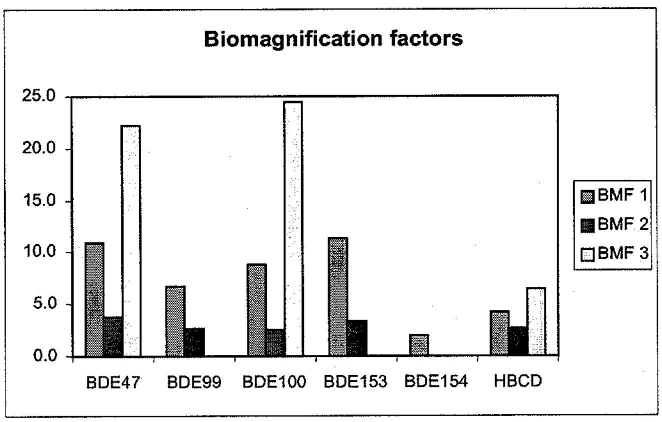


Figure 4.7. Biomagnification factors: BMF 1: mysid shrimp - gudgeon, BMF 2: praunus – gudgeon, BMF 3: copepods - gudgeon.

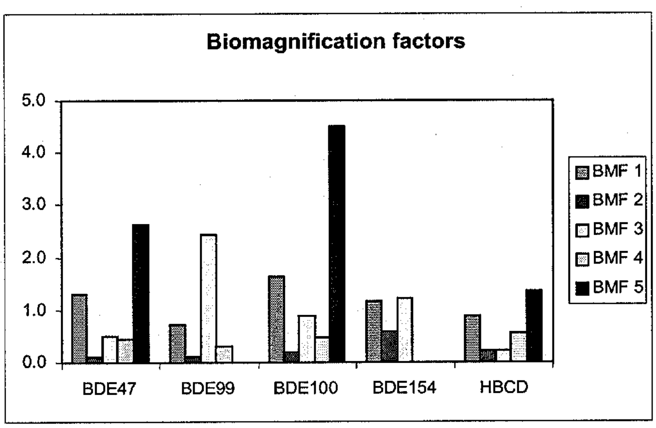


Figure 4.8. Biomagnification factors: BMF 1: mysid shrimp – common tern, BMF 2: gudgeon – common tern, BMF 3: greater sandeel – common tern, BMF 4: praunus – common tern, BMF 5: copepods – common tern.

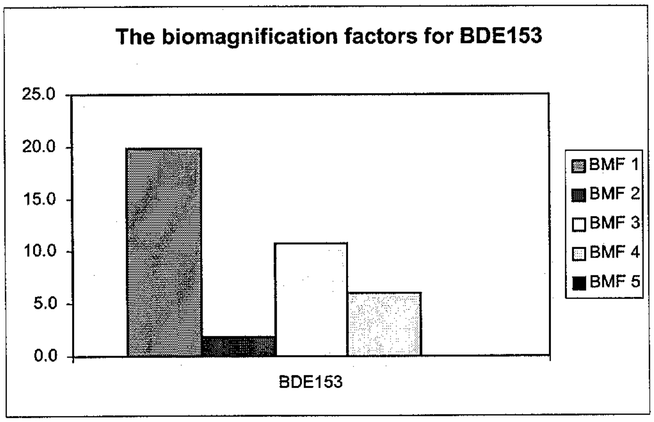


Figure 4.9: Biomagnification factors for BDE153. BMF 1: mysid shrimp – common tern, BMF 2: gudgeon – common tern, BMF 3: greater sandeel – common tern, BMF 4: praunus – common tern, BMF 5: copepods – common tern.

not as high as was expected. Possibly, the transfer of BDEs from the bird to the eggs is reduced for unknown reasons. Unfortunately, until now it was not possible to obtain bird tissue samples for analysis. Such an analysis could provide more insight in this matter.

BDE209 was only found in five common tern eggs. However, the concentrations were very close to the detection limits. This shows that, although Kierkegaard et al. (1999) have reported that decaBDE can be accumulated in rainbow trout, this accumulation is apparently marginal for most fishes and smaller aquatic organisms.

Table 4.1. PBDE and HBCD concentrations in biota from the Western Scheldt, in ng/g lipid weight.

Organism	n	BDE 47	BDE 99	BDE 100	BDE 153	BDE 209	HBCD
Mysid shrimp*	9	100	64	22	<10	<50	450
Praunus	1	300	160	76	20	<60	720
Clupeid larvae	1	51	<9	8.0	<9	<37	290
Gudgeon	6	1130	430	200	68	<17	1870
Gr. sandeel	3	260	19	41	11	<20	1720
Common tern eggs	15	130	46	36	120	12**	390***

* 7x M. mesopodopsis, 1x M. schistomysis, 1x M. gastrosaccus; ** n=5, other values < detection limit; ***excl. one value of 3846 ng/g.

In addition to the 15 common tern egg samples from Terneuzen, 15 other tern egg samples from the Maasvlakte (Dutch coast near Rotterdam) were analysed (Annex 5.4). The results are summarised in Table 4.2. Roughly, the BDEs 47 and 99 are 3-fold lower near Terneuzen, while HBCD is 3-fold higher in eggs from Terneuzen. However, also in the Maasvlakte tern eggs, HBCD was found at a mean level of 95 ng/g lipid weight. This confirms the bioaccumulative potential of HBCD.

Table 4.2. BDE and HBCD concentrations in common tern eggs from the Western Scheldt (Terneuzen) and the Maasvlakte, expressed in ng/g lipid weight.

Location	BDE 47	BDE99	HBCD
Terneuzen	130	46	390*
Maasvlakte	410	150	95

* one value of 3846 ng/g lipid weight not included.

5. Work package 2 – Surface sediments

Sediments from the Western Scheldt, The Netherlands and the river Tees, UK were analysed for PBDEs. In the Western Scheldt samples, also HBCD was measured. The results are given below.

5.1 Western Scheldt

All PBDE and HBCD concentrations in sediments from the Western Scheldt are given in Annex 6. The annexes 6.2-6.5 show the distribution of the BDEs 47, 99 and 209, and HBCD in the Western Scheldt with a focus on the area around Terneuzen.
The samples (19 in total) were all taken by a Van Veen grab at dry parts during low tide. The samples were pooled samples based on nine sub-samples taken within a square area of ca. 100 m^2. Clearly, the highest concentrations found in Western Scheldt sediment are those of BDE209, with a mean of 172 ng/g dry weight and a maximum value close to 1 mg/kg dry weight. Comparable BDE209 concentrations were reported by de Boer et al. (2000) in sediment and suspended particulate matter from the Western Scheldt. In that study, the highest BDE 209 concentrations were found east of Terneuzen (Schaar van Ouden Doel, location no. 54), which could indicate a main contamination coming from Antwerp, possibly related to the textile industry. The picture revealing from this study confirms the higher decaBDE levels in the east part of the Western Scheldt, but comparable concentrations are also found at two other locations: Terneuzen and close to Vlissingen. It is possible that tidal movements in the river would have transported a high PBDE input from Terneuzen to the east side of the town. However, the most likely explanation of the patterns found is that there are two point sources: Antwerp and Terneuzen. Possibly, a third one is Vlissingen, but this should be confirmed, as this is based on one location only and was not confirmed in the earlier study of de Boer et al. (2000). The HBCD distribution in the Western Scheldt is comparable to that of BDE209, with relatively high levels at Antwerp, Schaar van Ouden Doel, Terneuzen, and Vlissingen. BDE 47 and BDE 99 concentrations are 500-1,000-fold lower than the BDE 209 concentrations. Other BDEs were generally low or below the detection limits.

5.2 Tees estuary

All results and the corresponding sampling locations are given in Annex 7. An extensive sediment survey of the Tees from source to sea was conducted which yielded approximately fifty samples. This was over double the number of samples originally proposed, but it was thought necessary to extend the original survey to provide enough information for both this Work Package and for Work Package 3 – Mass balance.
For ease of data interpretation the Tees was divided into four sections. These sections are identified in Annex 7 that also contains the precise positional data and results of the PBDE analysis. TOC and particle size data are provided in Annex 1.

The first section has been called the Upper Tees, this runs from the source of the river in Teesdale (effectively Cow Green reservoir) downstream to Croft on Tees (excluding the confluence with the R. Skerne). The next section has been called the Middle Tees and runs from Croft on Tees to the Tees Barrage. Tees Barrage to Tees Mouth forms the Lower Tees and finally Tees Mouth and Tees Bay have been combined and called the Tees estuary.
Samples collected from aboard the RV Cirolana were collected with a modified Day grab, samples collected by small boat or from land were collected with a small scale hand held Day grab.

Annex 1 shows a graphical presentation of the sample positions on each section of the river. The Tees in it's upper stretches is one of the fastest flowing rivers in England, but in its lower reaches it is slow and sluggish, meandering over a level of slightly undulating plain, before emptying into the sea through a wide bell shaped estuary. The bed of the upper river is largely of gravels and rock moving to areas of silt, sand and gravel further down stream.
PBDEs were not detected in sediment samples from the Upper section of the river although a low concentration of 1 µg/kg dry weight of BDE209 was observed at Winston Gate Bridge. These results were unsurprising given the lack of any industry in the area. There is a sewage treatment works at Barnard Castle, but this is thought to be largely dealing with domestic sewage from this very rural area.
BDE209 and BDE47 were both seen at the last sampling point before the confluence with the River Skerne at Croft on Tees at concentrations of 1 and 0.21 µg/kg dry weight respectively (close to the detection limits).
At the first sampling point downstream of the confluence with the River Skerne BDE209 was measured at 107 µg/kg dry weight and the Sum BDE concentration (which excludes BDE209) rose to 73 µg/kg.
Concentrations generally declined through the rest of this section although a sample taken from the River Leven, a major tributary of the Tees which joins the river south west of Middlesbrough, contained 40 µg/kg Sum BDE, but interestingly BDE209 was not detected in this sample.
All samples from the Lower Tees were contaminated with PBDEs with values ranging from 7 – 61 µg/kg dry weight Sum BDE with a mean of 13 µg/kg. When normalised to <63µm fraction this value rose to 22 µg/kg and to 283 µg/kg when normalised to TOC.
It should be pointed out that although normalisation to TOC is common for marine sediments the River Tees, in common with other rivers on the east coast of England does contain significant quantities of coal particles and these can lead to high TOC values. A typical UK estuary would be expected to have TOC levels of around 2%, in this survey values ranged from 0.38 to 10.25%
BDE209 concentrations in the Lower Tees sediments were often (but not exclusively) higher than the Sum BDE value. The mean for BDE209 was 140 µg/kg dry weight, tens times higher than the mean value for Sum BDE.
The Tees estuary yielded the highest BDE209 concentrations with a mean of 240 µg/kg dry weight still approximately tens times higher than the mean Sum BDE value of 26 µg/kg dry weight.
An extreme value of 1400 µg/kg dry weight for BDE209 was measured at the sampling point just off Dabholm Gut which is probably the most significant mixed industrial and domestic sewage discharge to the Tees estuary.
The BDE209 and Sum BDE concentrations were highly variable in the estuary probably due to a combination of diffuse and point source inputs and the varied nature of the river beds which contains areas of gravel, sand, silt and cohesive muds.
Once leaving the estuary the PBDE levels generally declined quite rapidly in the sandier sediments, although there were localised pockets of elevated levels and some evidence of elevated levels of PBDEs in the region of the main Tees dredge spoil disposal ground.

The sediment BDE profiles, although quite varied, were generally dominated by BDE47, 99 and 100, the primary congeners present in the penta mix DE-71 which was known to be produced until the late nineteen nineties at a plant at Newton Aycliffe on the River Skerne. This plant apparently did not produce the deca compound (BDE209, DE-83R) although it may have been handled at the site. It seems quite probable that there are other and possibly multiple sources of the deca compound in the Tees catchment.
The sample from the River Leven contained more penta mix related congeners and no decaBDE.

6. Work package 3 – Mass balance range

6.1 Background

This part of the program aimed to provide estimates of the PBDE inventory within the Tees estuary and estimate export rates of the material outside the estuary.
A literature search on the Tees found relatively little work published in the open literature. Lewis and Lewis (1983, 1987) describe the hydrodynamics of the system, including the role played by the density driven circulation, but do not discuss the sediment regime in any detail. Fortunately useful information exists as the result of work commissioned by the Tees and Hartlepool Port Authority (THPA). Reports from some of these studies are in the public domain, including a numerical modelling study (HR 1989), of siltation rates undertaken prior to the building of the tidal barrage, and a follow up study (HR 1999) assessing the accuracy of the original predictions. In addition considerable local knowledge exists with THPA engineers concerned with the dredging operations who have been a very useful source of information. A general assessment of the estuary is co-ordinated by the Environment Agency, which has issued a number of reports (EA 1999) outlining the (generally improving) environmental state of the estuary.
Since the building of the tidal barrage in 1995, sedimentation rates have dropped but are still significant, requiring constant maintenance dredging to be undertaken. Marine sediments are the dominant source of material. The assumption used in the modelling studies (HR 1989) is that siltation rates are controlled by the levels fine suspended material in Tees Bay, although the ultimate source of this material is not specified. Winter storms are assumed to re-suspend this material leading to enhanced water levels concentration and net in-filling of the estuary to occur. However, port authority engineers supervising dredging operations recommend caution in accepting the details of the modelling studies (Mr. A Ridley *pers. com.*), although in general the assumptions used in the modelling seem reasonable. In addition to accumulation of fine material, a significant input of sand occurs, coming from the north with the general transport paths in the region. Interestingly, it is thought that none of the dredged material disposed of outside the estuary (6 km offshore in 30 m water depth) re-enters the estuary. A recent study (not in the public domain) supports this conclusion.

In general the following is known about siltation rates in the estuary. Figures are given in terms of volume (wet). Records of dredging activity indicate that since the building of the barrage, on the order of 500 000 m^3 /year of sediment needs to be removed to maintain a constant depth in the stretch from the tidal barrage, approximately 15 km upstream, to the mouth (See map in Annex 1). The 0.5 x 10^6 m^3 /year implies an accumulation depth of 0.25 ~0.5 m/year averaged over the whole estuary. Conversion to a tonnage is complicated by the value used for the dry density to convert from wet volume to dry weight. Depending on the silt content this can range from 0.3 tonnes/m^3 (very fine) to 1.2 (very sandy) tonnes/m^3. Using a value of 0.5 tonnes/m^3, a rough estimate of the average dry weight of sediment disposed of is then 250 000 tonnes/year.

6.2 Conceptual Model

A simple box conceptual model of the processes operating within the estuary and the exchange with the outside has been developed. Compartments representing water, suspended particulates, sediment on the channel bed (dredged) and sediment on the banks (non-dredged) are included. Mass and contaminant exchange occurs between each. Appendix 8 gives a schematic of the model structure. The conceptual model has also been implemented as a set of routines in the Mathematica™ computer mathematics package. This allows the effect of different assumptions about input and exchange rates to be explored. Information that is available includes data on the partition coefficient between dissolved and particulate forms of ~1.0×10^5 for the Penta compounds.

A general conclusion from a number of sensitivity runs is that due to the very high levels of dredging activity, any contaminants accumulating with sediments in the estuary will be exported to the disposal ground within a perhaps a year of release. An exception to this is material on the undredged banks of the estuary. It has not been possible to ascertain the likely fate of this material. Some may be washed into the main channel due to wash from passing vessels, some may accumulate in more sheltered locations. At present the model assumes so-called 'slump' occurs and material moves off the sides into the dredged channel carrying any contaminants with it. This material is then removed by dredging.

The fate of material disposed of outside the estuary is not known for certain. However, despite disposal over a period in excess of 30 years not noticeable bathymetric change has occurred at the disposal site - leading to the conclusion that the site is dispersive. Given the known residual transport paths in the region, it seems likely that material will move south, possibly moving towards the Dogger bank with the observed summer density driven residual (Brown et. al. 1999, 2001).

6.3 Inventory

Without the knowledge of historical inputs we attempt only to quantify present inventories and export rates. The main difficulty in making an inventory is knowledge of the depth distribution of PBDEs. We take this to be the average yearly siltation depth which is of the order of ~0.3 m/year.
Results for inventories of all PBDEs (written as Σ PBDE) apart from BDE209, and for BDE209 only, are presented separately in tables 6.1 and 6.2 respectively. An attempt is made to divide the Tees into sections and produce an inventory for each. Estimates of the total inventory are ~0.1 tonnes for BDE209 and ~0.01 tonnes for all the rest. These are maximum inventories assuming a years worth of sediment has accumulated and not been dredged out.

6.4 Export rates

In table 6.3 we give estimates of upper and lower bounds for export, due to dredging at the present time, as tonnes per year. Again results are presented separately for Σ PBDE and PDE209. All export is calculated essentially by multiplying the weight of dredged material disposed of (kg/year) by the PBDE concentration (μg/kg) and converting to tonnes. The conversion from volume of dredged material to dry weight requires the dry density of the settled sediment, which depends on the composition of the material.

	Middle Tees	Lower Tees	Tees mouth	Lower+mouth
PBDE Mean (ug/kg dry)	52	12.82	26.51	
PBDE Std Dev (ug/kg dry)	115.00	16.68	31.28	
PBDE Range (ug/kg dry)	1 - 288	<0.2 - 61	<0.2 - 1400	
Number samples	6	15	22	
Estuary Length (m)	15000	12000	3000	
Estuary Width (m)	125	200	300	
Estauary Area (m2)	1.88E+06	2.40E+06	9.00E+05	5.2E+06
Siltation rate (m3/a)	NA	2.3E+05	3.4E+05	5.7E+05
Average thickness (m/a)	6.7E-03	9.5E-02	3.8E-01	
Volume (m3/a)	1.25E+04	2.28E+05	3.40E+05	5.8E+05
Volume fraction	0.3	0.2	0.3	
Dry density kg/m3	780	520	780	
Average weight (tonnes)	9.8E+06	1.2E+08	2.7E+08	3.8E+08
PBDE Inventory (tonnes)	5.1E-04	0.002	0.007	0.009

Table 6.1: Σ PBDE inventory estimate.

	Middle Tees	Lower Tees	Tees mouth	Lower+mouth
PBDE Mean (ug/kg dry)	28	139	240	
PBDE Std Dev (ug/kg dry)	52	117	398	
PBDE Range (ug/kg dry)	<0.05 - 288	10.3 - 378	<0.05 - 92	
Number samples	6	15	22	
Estuary Length (m)	15000	12000	3000	
Estuary Width (m)	125	200	300	
Estauary Area (m2)	1.88E+06	2.40E+06	9.00E+05	5.2E+06
Siltation rate (m3/a)	NA	2.3E+05	3.4E+05	
Average thickness (m/a)	6.7E-03	9.5E-02	3.8E-01	
Volume (m3/a)	1.25E+04	2.28E+05	3.40E+05	5.8E+05
Volume fraction	0.3	0.2	0.3	
Dry density kg/m3	780	520	780	
Average weight (tonnes)	9.8E+03	1.2E+05	2.7E+05	3.8E+05
PBDE Inventory (tonnes)	2.8E-04	0.016	0.064	0.1

Table 6.2: BDE209 inventory estimate.

An estimate is made of the loss of PBDE from the Tees due to exchange of water and particulates with the coastal sea outside. Two mechanisms need to be accounted for:

1. Flushing due to residual transport through the estuary arising from the fresh water inflow,
2. The down gradient transport via exchange of material arising from oscillating tidal flow at the mouth.

Given the fresh water flow rate, estimates of the loss of PBDE can be calculated once estimates of the water and particulate volume PBDE concentration are made. These can be estimated roughly from the observed concentrations on the bed sediments and a Kd (partition coefficient) value. The tidal exchange requires values of cross sectional area and tidal velocities near the estuary mouth and an estimate of the tidal exchange ratio. The latter is essentially the fraction of water volume coming in at flood that is 'new' i.e. wasn't advected out the estuary during the previous flood. We have used a relatively large value (0.1) for this to get more like an upper bound. In principle the value of the tidal exchange ratio can be estimated for an actual estuary if suitable salinity measurements are available (Fischer et. al. 1979).

	Low	High	Mean
Siltation rate (m3/a)	5.00E+05	1.40E+06	9.50E+05
Volume fraction	0.2	0.3	0.25
Sediment density	2600	2600	2600
Siltation rate (tonnes/a)	2.60E+05	1.09E+06	6.18E+05
BDE209 channel (ug/kg dry)	13	378	193
Sum PBDE channel (ug/kg dry)	11	61	25
Assume export=siltation rate			
BDE209 export (tonnes/a)	0.003	0.413	0.119
Sum PBDE (tonnes/a)	0.003	0.067	0.015

Table 6.3: Estimates upper, lower and mean exports from Tees estuary based on measured sediment concentrations and dredging rates.

Exchange data		
Tidal exchange area (m2)	5000	5000
Tidal velocity (m/s)	0.3	0.3
River flow (m3/y)	1.01E+09	1009152000
Tidal exchange ratio	0.1	0.1
Sediment concentration (kg/m3)	0.05	0.05
Concentrations	**Σ PBDE**	**BDE209**
Concentration on estuary sediments (tonnes/kg)	2.5E-11	2.0E-10
Kd	1.0E+05	1.0E+06
Water concentration - estimated (tonnes/m3)	2.5E-13	2.0E-13
SPM concentration - estimated (tonnes/m3)	1.25E-12	1.0E-11
Loss		
Via water export (tonnes/y)	2.5E-04	2.0E-04
Via water exchange (tonnes/y)	1.2E-03	9.5E-04
Via particle export (tonnes/y)	1.3E-03	1.0E-02
Via particle exchange (tonnes/y)	5.9E-03	4.7E-02
Total BDE209 (tonnes/y)		0.06
Total Σ PBDE (tonnes/y)	0.01	

Table 6.4: Estimates of loss from estuary via flushing and water exchange at the estuary mouth.

The results are shown in Table 6.4. Compared with the export due to dredging, values of export due to natural processes are about half. Since we are only dealing with orders of magnitude for all these estimates it is concluded that the export due to natural processes is of the same order as the dredging export.
The final results give a range as follows:

- BDE209 of 0.06 to 0.45 (mean 0.15) tonnes/year.
- Σ PBDE of 0.01 to 0.08 (mean 0.03) tonnes/year

6.5 Extension to other east coast UK estuaries

An estimate is attempted of the total UK input of PBDEs to the North sea based on an analogous calculation to that for the Tees by considering the disposal rates of dredged material from each. Because very limited measurements of PBDE contamination levels are available for these estuaries they have to be assumed. Two values are given for the total input. An upper value, assuming PBDE sediment concentrations are the same as the Tees and a lower one assuming they are an order of magnitude less. Values for Humber and Ouse (draining into the Wash estuary) sediments are reported in Allchin et al., 1999 but consist of a single sample. Although these measurements are indicative of the levels expected we have not used these values directly in the estimates below but have considered an upper and lower bound as for the other estuaries. The measured values for Humber are consistent with the upper end of the range for ΣPBDE and the lower range end for BDE209.

Wet weight dredge (tonnes	6.30E+05	1.77E+06	1.32E+07	2.30E+06	2.00E+06	
Approx wet to dry conversio	0.5	0.5	0.5	0.5	0.5	
Dry weight dredge (tonnes/	3.15E+05	8.87E+05	6.58E+06	1.15E+06	1.00E+06	
Sum PBDE						
Low (ug /kg)	2.5	2.5	2.5	2.5	2.5	
High (ug/kg)	25	25	25	25	25	
Low Export (tonnes/a)	7.9E-04	2.2E-02	1.6E-02	2.9E-03	2.5E-03	4.5E-02
High Export (tonnes/a)	7.9E-03	2.2E-02	1.6E-01	2.9E-02	2.5E-02	2.5E-01
BDE209						
Low (ug /kg)	19.3	193	19.3	19.3	19.3	
High (ug/kg)	193	193	193	193	193	
Low Export (tonnes/a)	6.1E-03	1.7E-01	1.3E-01	2.2E-02	1.9E-02	3.5E-01
High Export (tonnes/a)	6.1E-02	1.7E-01	1.3E+00	2.2E-01	1.9E-01	1.9E+00

Table 6.5 Estimated ranges of total UK input to the North Sea based on dredging.

The results are shown in Table 6.5 and use the last available dredging data for 1997 (CEFAS 2000). The results give an estimate of the possible total UK input to the North Sea that is between 0.03 to 0.1 tonnes/year for ΣPBDE and 0.2 to 0.8 tonnes/year for BDE209. The values are heavily influenced by the export from the Humber and the assumption about the uncertain levels of PBDE concentrations in these sediments. We have not attempted to estimate 'natural' export rates from these estuaries but by analogy with the Tees these might be expected to be less than the dredging input but of the same order.

7. Work package 4 – Sediment cores

Five of the cores were dated at the NIOZ. The cores were sliced in very thin layers (0.5 cm) and a small part of it was used for dating. The cores were dated by the isotopes Pb 210 and Cs 137 (Annex 9). The isotopic profile of Cs 137 in the Drammenfjord core shows maxima in 1963, which represents the maximum fallout of atmospheric atomic bomb testing and in April 1986, representing Tjernobyl accident. Especially the second peak is very pronounced because the atmospheric circulation at that time transported high levels of fall-out to Northwestern Europe.
The lead and cesium activity in the core of the German Bight showed no response, which indicates that the sediment was old. The core of the Skagerrak does not show such a sharp Cesium profile as which was seen in the Drammenfjord core. Although

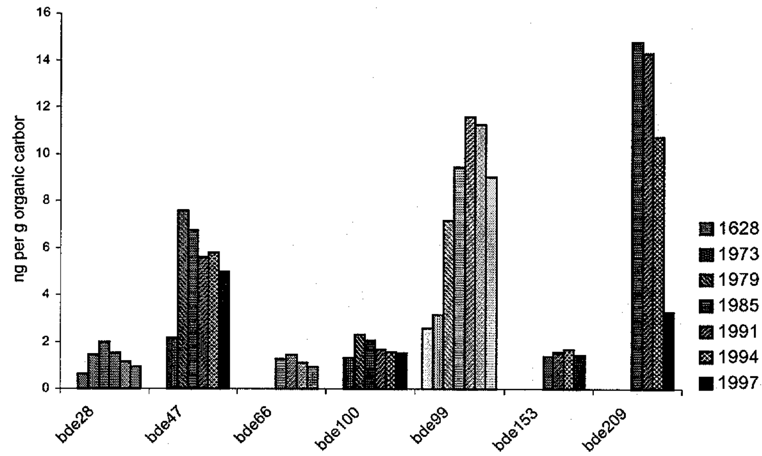


Figure 7.1. Concentration of the BDE congeners present above the detection level in a sediment core from Lake Woserin, Pommeren, Germany.

they are coming from the same region, this can be due to bioturbation which is absent in the Drammenfjord. The cores of the freshwater lakes have both a surface mixed layer on the top of the sediment. Therefore the sedimentation of BDE can be expected to be rather diffuse especially as the timeframe of interest is rather short. The University of Potzdam performed dating from the core of the Lake Woserin and the dating of the core from the Western Wadden Sea has been done at the NIOZ in the past.
The results of the cores show that the majority of the BDE congeners become present in the late nineteen sixties, and BDE209 emerges about a decade later. This is in agreement with the industrial production figures. BDEs 47, 99 and 209 are the most common congeners found, whereas BDEs 28, 66, 75, 85, 100, 153 and 154 are regularly found at lower concentrations. The BDEs 71, 77, 138 and 190 are not detected in the cores studied.
In the Lake Woserin core (gift of prof. Negendank, University of Potsdam, Germany), the levels of all the BDE congeners present were within the same order of magnitude (Figure 7.1). The increase of all BDEs except BDE 209, starts in 1973. The PBDE levels are similar to the concentrations in the Drammenfjord. The concentrations of the congeners level off in the nineteen eighties, just when BDE 209 is appearing for the first time in the sediment. This is in agreement with the shift in production volume from PeBDEs towards the higher brominated formulations. Remarkable is the decrease in BDE 209 in recent years.
In the core from the western Wadden Sea (Figure 7.2), the relative amounts of BDE209 are much higher than in Lake Woserin, indicating the possibility of a local source. Other work has identified the Scheldt estuary at the boarder between the

Netherlands and Belgium as a possibility. The originally southbound current from the Western Scheldt turns clockwise by a gyre off Ostend and merges with North Sea coastal water which moves with a residual northeasterly current along the Dutch coast to the western Wadden Sea. The other congeners in the core show very low levels, which obscures the calculation of their ratios.
In the core of the Drammenfjord the levels of all BDEs increase until 1999. The ratios between BDEs 47, 99, and 100 remain highly similar during the last 30 years (Figures 7.3 and 7.4). They are also similar to the ratios found in the Bromkal 70-5DE PeBDE formulation. When this, or a similar formulation, is a main source, it would imply a high degree of persistence of these compounds to degradation processes in the sediments.
In the Drammenfjord core, the levels of BDE209 dominated over the levels of the lower brominated PBDEs since the 1980s. In time, the BDE 209 profile legs somewhat behind the other BDEs as the concentration starts to rise at the end of the seventies of the last century. The increase continues during the last two decades and the little increase for 1999 might be caused by the difference in consistence of the top layer. The same decrease of BDEs in the top layer is also seen for other congeners. Most other lower brominated compounds follow the same pattern, with a rise in concentration since the early seventies. As for the moment no real decrease or levelling off can be observed. BDE66 shows a unique pattern: it is already present in a slice of 1957 and has a max at 1973, but then drops down to a lower level when the other PBDEs are still on the increase.
In summary, the results of this work show that PBDE levels have a time-dependent pattern in these cores, with BDE209 arriving about one-two decades later than the congeners present in PeBDE mixtures such as Bromkal 70-5 DE. In the cores from the western Wadden Sea and Lake Woserin, the concentrations on organic carbon basis are leveling off, whereas those in the Drammenfjord are still increasing.
In samples from Saanich Inlet (Vancouver Island, 400 years old) and in Kimmeridge Clay Formation (Swanworth Quarry, Dorset, UK, 100-150 million years old) no BDE signal has been observed, showing an anthropogenic origin of the BDE.

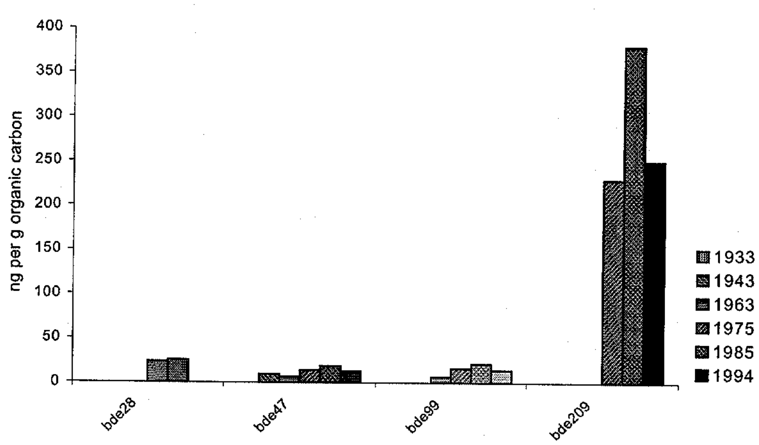
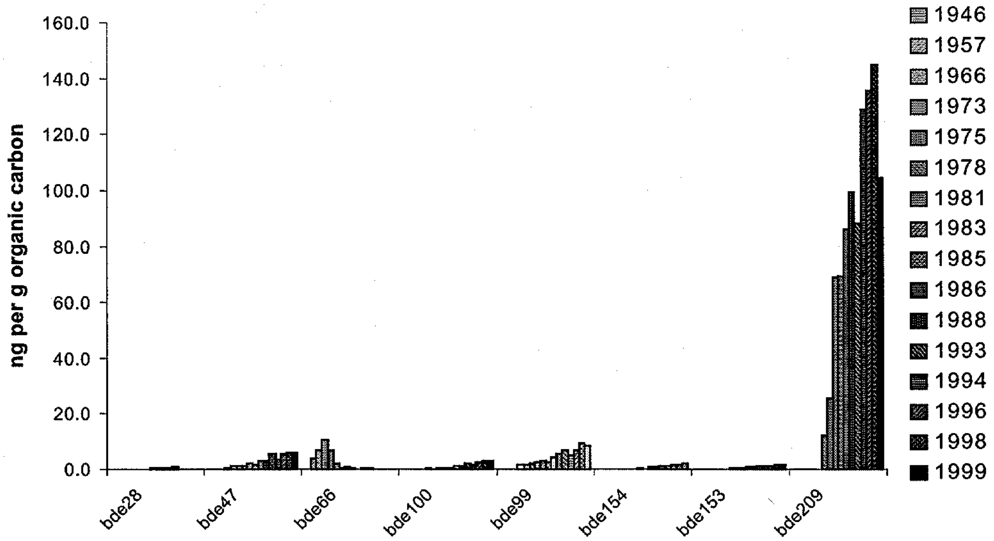
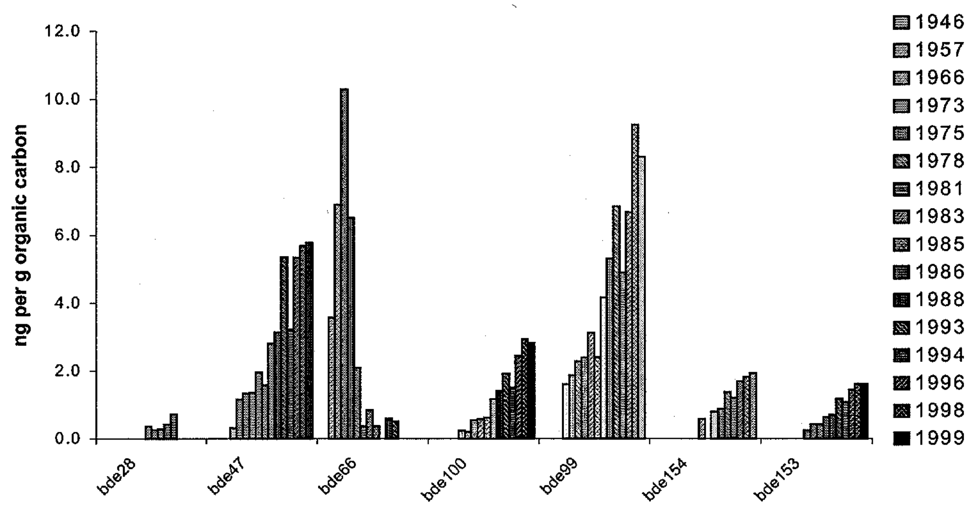


Figure 7.2. PBDE concentrations in a core from the Dutch Wadden Sea (De Vlieter).



Figures 7.3.PBDE concentrations in a core from the Drammenfjord (Oslofjord, Norway).



Figures 7.4.PBDE concentrations in a core from the Drammenfjord (Oslofjord, Norway) (enlarged section).

The cores from Skagerrak and German Bight (both from the North Sea) and the cores from the lake Meerfeld (Eifel, Germany) and Birkat Ram (Israel) have been dated at the NIOZ while samples of these cores were supplied to the RIVO for PBDE analysis. The BDE concentrations found in the Skagerrak and German Bight cores as well as in the Lake Meerfeld and Birkat Ram cores were close to the detection level. The lead and cesium activity in the core of the German Bight showed no response which indicates that the sediment was old (Annex 9). The top layer may have been removed completely due to severe water movements, which explains that all BDE concentrations were below the detection limits. The core of the Skagerrak does not show such a sharp cesium profile as which was seen in the Drammenfjord core.

Although they are coming from the same region, this can be due to bioturbation which is absent in the Drammenfjord. Only some BDE47 and 99 concentrations were detectable. The cores of the freshwater lakes have both a surface mixed layer on the top of the sediment. Therefore the sedimentation of BDE can be expected to be rather diffuse especially as the timeframe of interest is rather short. The analysis of the latter two cores was also hindered by a blank problem, which made it impossible to concentrate the final extracts to a smaller volume than 1 ml, as blank concentrations of the BDEs 47 and 99 started to interfere significantly. Attention will be paid to this problem. In spite of this problem, it can tentatively be concluded that aerial transport of PBDEs over Europe may be limited, given the relatively low level of PBDEs in this isolated lake sediment core.

8. Work package 5 - Recent Trends

All results of the samples analysed in the recent trend study are given in Annex 10. This study consists of three parts. In part one, European river sediments (Clyde, Humber, Tyne, Mersey, Scheldt) collected and analysed in 1995 under the DIFFCHEM program (Anon., 1997), were re-sampled and analysed in the period 1999-2001. The 1999 sampling locations were those of the DIFFCHEM samples (Anon., 1997). In part two, Dutch river sediments (Rhine and Meuse delta, and river Roer) collected and analysed in 1992, were re-sampled and analysed in 1999. In part three eels from rivers in The Netherlands (Rhine and Meuse delta, and river Roer), cod (liver) from the southern and central North Sea and hake liver from the Atlantic Ocean were collected and analysed in 1999 or 2001, and the results compared to samples from similar locations collected annually since the 1980s.

Table 8.1. Concentrations of BDEs sediments (in ng/g org. C), in comparison with DIFFCHEM study.

River	BDE47		BDE99		BDE209	
	1999-2001	1995	1999-2001	1995	1999-2001	1995
Liffey	22	30	20	36	4457	2010
Clyde	410	23	300	32	1260	259
Mersey	140	90	190	93	104700	69700
Tyne		37		52		230
Humber	22	240	16	290	160	1630
Western Scheldt	6.5	12	6.0	9.1	7716	5670

A summary of the results of this study and those of the DIFFCHEM study are compared in Table 8.1. All data can be found in the Annexes 1.3, 10.8 and 10.9. In the Western Scheldt between the years 1995 and 1999, BDE47 and 99 concentrations decreased by 50% and 30%, repectively, whereas BDE 209 concentrations increased 50%. Apart from this single location, 18 other locations were sampled in the Western Scheldt. The other locations BDE concentrations (630-12,000 ng/g org. C) showed a slight decreasing trend from Antwerp harbour (DIFFCHEM location) towards sea. The Liffey (Ireland) shows a similar trend between 1995 and 1999, with a decrease in BDE47 and 99 concentrations (ca. 50%), and an increase for BDE 209 (>100%).

The situation in the Clyde (UK) is completely different from that of the Western Scheldt and the Liffey. All BDE concentrations have increased between 1995 and 2000, BDE47 ca. 20-fold, BDE99 ca. 10-fold, BDE209 ca. 5-fold. Also in the Mersey, all BDE concentrations (tetra, penta and deca) have increased between 1995 and 2001. Relatively large uncertainties should be taken into account here, as the data showed a patchy pattern within the four replicate samples taken at these locations. In the Humber all BDE concentrations have ca. 10-fold decreased, which is a very deviating pattern from most other samples. Although five replicates were sampled, a possible influence of a patchy pattern may have played a role. TOC determinations in the river Tyne sediment have not been carried out, for the same reasons as given under WP 2: too high percentages of coal would disturb the normalisation. On a dry weight basis the BDE209 concentration in the river Tyne (UK) (1999) is 95 ng/g, which is much higher than the 3.3 ng/g (<63 μm fraction) which was found in the DIFFCHEM sample from 1995. Also, BDE47 and 99 levels have increased in this river since 1995.

In the second part of this study a few sediment samples from Dutch rivers were analysed and compared with 1992 samples from the same locations (Table 8.2, Annex 10.3). The BDE47 concentrations in the Rhine delta (Haringvliet, Waal and Nieuwe Merwede) have decreased ca. 5-30-fold, and ca. 10-fold in the river Meuse.

Table 8.2. Concentrations of BDEs in sediments from Dutch rivers (in ng/g org. C).

	BDE47		BDE99		BDE209	
River	1999	1992	1999	1992	1999	1999
Haringvliet-east	54	410	51	450	470	1510
Nieuwe Merwede	170	900	80	n.a.	910	8040
Waal (Tiel)	29	990	30	900	760	2310
Meuse (Keizersveer)	22	250	26	300	990	110

n.a.: not analysed

A similar decrease was found for BDE99 in the Rhine and Meuse delta. BDE209 was not analysed before in biota from these locations. The BDE209 concentrations in the Rhine and Meuse delta are considerably higher than the current BDE47 and 99 concentrations; in the Rhine delta they are similar to the 1992 BDE47 concentrations and in the Meuse 5-fold higher than in 1992.
PBDE concentrations in eel collected in The Netherlands from 1980-1999 were compared (Figures 8.1 and 8.2, Annex 10.1). Clearly, there was a decrease of the BDE47 and 99 concentrations over the last years, as was also shown in the sediment (Table 8.2).

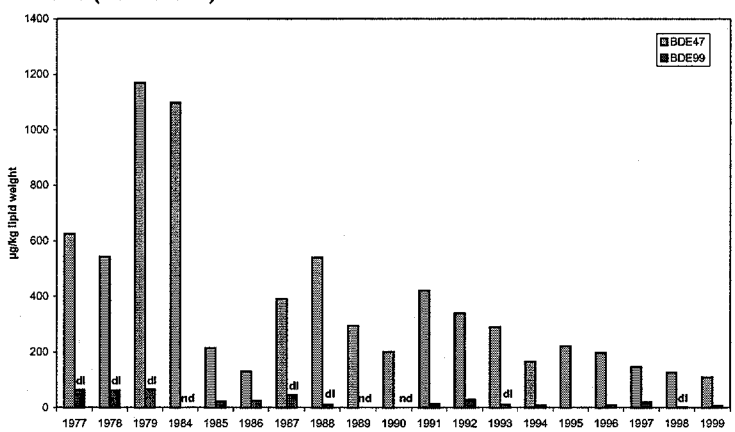


Figure 8.1. Trends of PBDE concentrations in eel from the Haringvliet-east (Rhine delta).

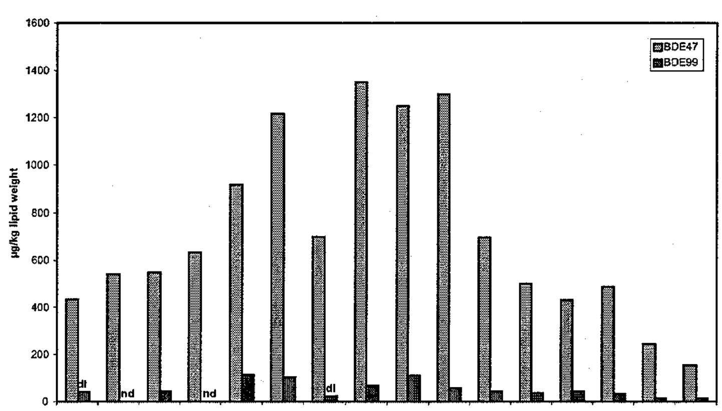
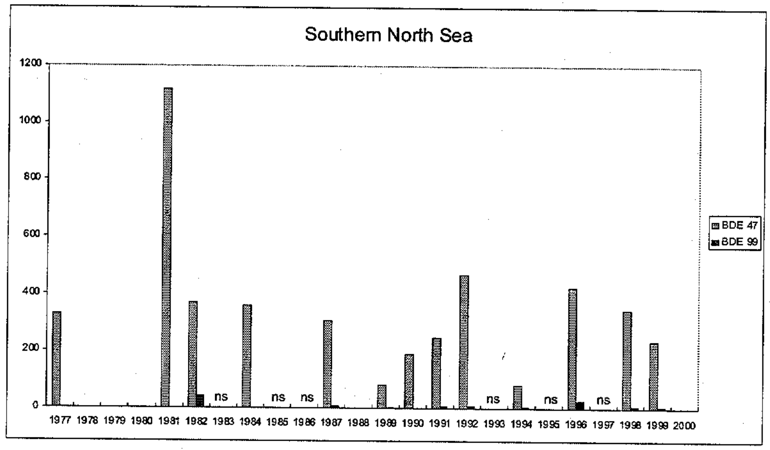


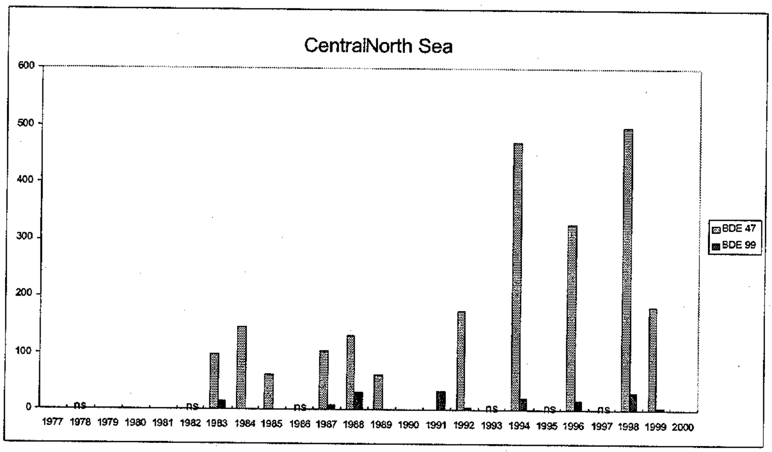
Figure 8.2. Trends of PBDE concentrations in eel from the river Roer.

Also, the increase of BDE47 and BDE99 concentrations in eel from the river Roer in the period 1987-1993, thought due to use of the pentabromodiphenylether product in German coal mining, is clearly visible (Figure 8.2), as well as the decrease of these levels after the termination of its use in these mining activities (de Boer, 1990). Trend graphs of other locations are shown in the Annexes 10.4-10.7. Finally, in the southern North Sea, BDE47 concentrations in cod liver decreased from 1000 ng/g (1983) to 240 ng/g lipid weight in 1999 and BDE99 concentrations from 22 (1983) to 7 ng/g ng/g lipid weight in 1999 (Figure 8.3, Annex 10.2). In the central North Sea, BDE47 and 99 concentrations were initially stable at a level of ca. 180 and 6 ng/g lipid weight, respectively, but since 1994 BDE47 concentrations up to 500 ng/g lipid weight have been found (Figure 8.4). Although the number of samples was very limited, these trends are consistent with the decreasing BDE47 and BDE99 levels in Dutch rivers which flow into the southern North Sea, and the increasing BDE47 and BDE99 levels in some UK rivers which may influence the central North Sea.



ns= no sample

Figure 8.3. Trends of PBDE concentrations in cod liver from the southern North Sea.



ns= no sample

Figure 8.4. Trends of PBDE concentrations in cod liver from the central North Sea.

The following BDE concentrations were found in a hake liver sample from 2001 (pooled sample of 25 livers), south-west from Ireland: BDE47: 22 ng/g wet weight, BDE100 4.1 ng/g, and BDE99 <3 ng/g. In hake liver, sampled west from Ireland in 1986, BDE47 was <20 ng/g wet weight, and BDE99: <10 ng/g. Hake liver sampled in 1983 in the Bay of Biscay contained 70 ng/g BDE47.
It should be taken into account that the data presented are subject to a relatively large variation because, i) the DIFFCHEM study was only meant as a survey to map geographical differences in contaminant loads in Europe, ii) different laboratories have been involved in the analysis, applying different methods in different periods, and iii) sediments may show patchy patterns, which can influence the data markedly in case of limited sample numbers. Therefore, temporal trends in a strict statistical sense cannot be demonstrated. However, in spite of these limitations, some indications of temporal trends may be visible. A decrease of BDE47 and 99 (eel, cod liver and sediment) concentrations and an increase of BDE209 (sediment) can be observed in the Dutch rivers Rhine, Meuse and Scheldt, the southern North Sea, and in the Liffey (Ireland). Sediments from UK rivers show deviating trends: the Clyde and Tyne with an increase of tetra, penta and decaBDE since 1995 and the Humber with a decrease of tetra, penta and decaBDE. The sediment core study (see Chapter 7) indicates a leveling-off of the tetra and pentaBDE over the last ten years in cores from the Dutch Wadden Sea and Lake Woserin (Germany), while decaBDE concentrations had increased markedly in the late 1970s. A sediment core from the Oslofjord (Norway) showed increasing tetra and pentaBDE levels until 1999. It appears that regional differences in tetra and pentaBDE trends occur in Europe. DecaBDE concentrations have reached relatively high levels in some sediments. DecaBDE was not found in eel and cod liver samples, showing its very limited bioaccumulative properties.
HBCD in the Rhine delta is 3-fold higher than the BDE 47 concentrations in 1992, but in the Meuse the HBCD concentrations are 2-fold lower than the BDE 47 concentrations in 1992. The absolute HBCD level in the river Rhine is 20-80-fold higher than that in the river Meuse. The sources of the PBDEs and HBCD in the rivers Rhine and Meuse are unknown. Possibly, sewage treatment plants play an important role, as the study by de Boer et al. (2000) showed that PBDEs could pass sewage treatment plants, and relatively high levels of PBDEs, in particular of deca BDE were found near sewage treatment plant outlets. Possibly, PBDEs in dust (Santillo et al., 2001) may finally end up in sewage systems through washing machines or via other ways.

9. Work package 6 – Publication on analytical methods

In this work package a study on the extraction of PBDEs was carried out. In addition, a series of intercomparisons among the three partners was organised. Based on the results of these studies, a draft paper on a preferred analytical method for PBDEs was prepared and submitted to Trends in Analytical Chemistry (Annex 12).

10. Work package 7 – Interlaboratory study

An interlaboratory study on the analysis of PBDEs in biota and sediments was organised between November 1999 and April 2000. Eighteen laboratories from nine different countries in Europe, North-America and Asia participated in this study. The results are presented in a separate report (de Boer, 2001). A good comparability was found for the analysis of BDE 47, with relative standard deviations (Rsd) of 17-40%. Less good results were obtained for the other BDEs, in particular for BDE99 which most likely suffers from interferences in the chromatogram and for BDE209. It was clearly visible that analytical methods for the latter were still under development in many laboratories. The Rsd values obtained for BDE 209 in sediment ranged from 48-78% for only nine and six laboratories, respectively. Another important observation of this study was that high resolution mass spectrometry (HRMS) was not necessarily better than low resolution (LR)MS.

13. References

Allchin, C.R., Law, R.J., Morris, S. (1999). *Environ. Pollut.* 105, 197-207.

Andersson, Ö., Blomkvist, G. (1981). *Chemosphere* 10, 1051-1060.

Anon. (1997). Report of the results of the one-off survey DIFFCHEM. Oslo and Paris Commissions, SIME97/6/1-E, London, UK.

Anon. (2000). An introduction to flame retardants, BSEF, Brussels, Belgium.

Lindström, G., Wingfors, H., Dam, M., and van Bavel, B. (1999). *Arch. of Environ. Contam. Toxicol.* 36, 355-363.

de Boer, J. (1990). *Organohalogen Compounds* 2, 315-318.

de Boer, J. and Dao, Q.T. (1993). Overview of PBDE data. RIVO report, IJmuiden, The Netherlands.

de Boer, J., Wester, P.G., Klamer, H.C., Lewis, W.S., Boon, J.P. (1998). *Nature* 394, 28-29.

de Boer, J., van der Horst, A., Wester, P.G. (2000). *Organohalogen Compounds* 47, 85-88.

Brown, J., Hill, A.E., Fernand, L. and Horsburgh, K.J. (1999). *Estuarine Coastal and Shelf Science* 44, 343-355.

Brown, J., Fernand, L., Horsburgh, K.J., Hill, A.E. and Read, J.W. (2001). *Journal of Plankton Research* 23, 105 -116.

CEFAS 2000, Monitoring and surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of waste at sea, 1997, *Aquatic Environment Monitoring Report* No. 52. Centre for Environmental Fisheries and Aquaculture Science, Burnham on Crouch Laboratory, Essex, UK

EA 1999, Tees Estuary: Present and Future – State of the Tees Estuary Environment, and Strategy into the Millennium, Environment Agency report, Swan House, Merchants Wharf, Westpoint Road, Thornaby, TS17 6 BP.

Fischer H.B., List J.E., Koh R.C.Y., Imberger J., Brooks N.H. 1979, Mixing in Inland and Coastal Waters, Academic Press, New York.

Goldberg, E.D. (1975). Proc. Roy. Soc. London Ser B, 189, 277-289.

Gribble, G.W. (1998). *Accounts of Chem. Res.* 31, 141-152.

Gribble, G.W. (1999). *Chem. Soc. Rev.* 28, 335-346.

Gribble, G.W. (2000). *Environ. Sci. Pollut.* Res. 7, 37-49.

Haglund, P.S., Zook, D.R., Buser, H.-R., Hu, J. (1997). *J. Environ. Sci. Technol.* 31, 3281-3287.

HR 1989, Tees Barrage, *Report EX1975*, HR Wallingford, Howbery Park, Oxon, UK

HR 1999, Accuracy of Marine Siltation Predictions, *Report SR550*, HR Wallingford, Howbery Park, Oxon, UK

Kierkegaard, A., Balk, L., Tjärnlund, U., de Wit, C.A., Jansson, B. (1999*). Environ. Sci. Technol.* 33, 1612-1617.

Law, R., Allchin, C, Bennett, M. and Morris, S. (2000). Polybrominated diphenyl ethers in the blubber of marine mammals stranded on the coasts of England and Wales. Poster presented at the SETAC Third World Congress, Brighton, UK, 22 to 26 May 2000.

Lewis R.E. Lewis J.O. (1983), *Estuarine, Coastal and Shelf Science* 26, 599-626.

Lewis R.E. Lewis J.O. (1987), *Estuarine, Coastal and Shelf Science* 25, 621-635.

Lindstrøm, G., Wingfors, H., Dam, M., van Bavel, B. (1999). Arch. Environ. Contam. Toxicol. 36, 355-363.

Loganathan, B.G., Kannan, K. (1994). *Ambio* 23, 187-191.

Meyronité, D., Bergman, Å., Norén, K. (1998). *Organohalogen Compounds* 35, 387-390.

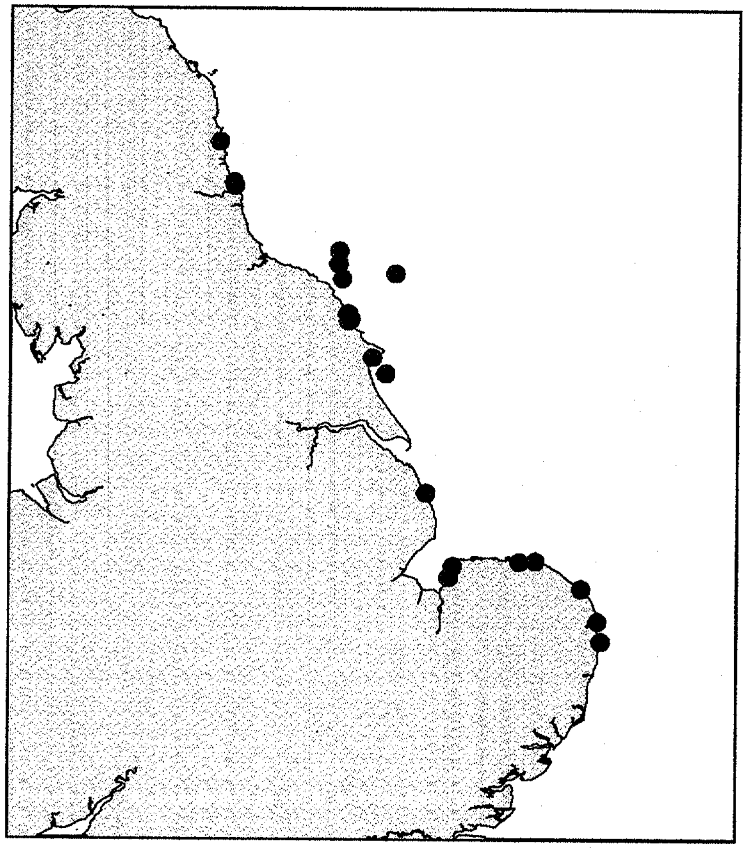
Norén, K., Meyronité, D. (1998). *Organohalogen Compounds* 38, 1-4.

Pijnenburg, A.M.C.M., Everts, J.W., de Boer, J., Boon, J.P. (1995). *Rev. Environ. Contam. Toxicol.* 141, 1-26.

Santillo, D., Johnston, P., Brigden, K. (2001). Greenpeace Technical Note 03/2001, Greenpeace, Exeter, UK.

Sellström, U., Jansson, B., Jonsson, P., Nylund, K., Odsjö, T., Olsson, M. (1990). *Organohalogen Compounds* 2, 357-360.
Sellström, U., Kierkegaard, A., de Wit, C., Jansson, B., Asplund, L. (1996). *Organohalogen Compounds* 28, 416-421.
Sjödin, A., Jakobsson, E., Kierkegaard, A., Marsh, G., Sellström, U. (1998). *J. Chromatogr.* A 822, 83-89.
Spiegelstein, M. (2000). Presentation at BSEF PBDE workshop, IJmuiden, The Netherlands.
Stern, G.A., Ikonomou, M.G. (2000). Organohalogen Compounds 47, 81-84.
de Wit, C.A. (2000). Brominated flame retardants, Report 5065, Swedish Environmental Protection Agency, Stockholm, Sweden.
Wolf, M., Rimkus, G.G. (1985). *Dtsch. tierärztl. Wschr.* 92, 174-178.

Annex 1.9



Porpoise sample locations

Annex 1.1 **Particle size distribution and total organic carbon content (TOC) of Tees sediment samples**

Lower Tees (Tees Barrage to Tees Mouth)

LSN	Latitude	Longitude	Location	TOC	TON	Mean (mm)	Sorting	Skewness
00/2600	54.565383	-1.285767	R.Tees upstre	5.67	0.42	0.01	2.11	0.15
00/2340	54.59	-1.253333	Bamlett's Wh:	5.69	0.37	0.02	2.17	0.29
00/2341	54.590667	-1.243333	Bamlett's Bigl	5.13	0.34	0.02	2.18	0.40
00/2342	54.5915	-1.242667	Bamlett's Bigl	9.23	0.39	0.04	3.13	-0.65
00/2343	54.5875	-1.236667	Middlesbroug	6.04	0.41	0.02	2.05	0.43
00/2344	54.588	-1.236	Middlesbroug	4.13	0.17	0.05	2.42	0.85
00/2345	54.584667	-1.226	Tees Transpc	6.63	0.36	0.02	2.19	0.15
00/2346	54.585	-1.224167	Tees Transpc	6.09	0.30	0.02	1.96	0.63
00/2347	54.581333	-1.2105	Tees Storage	6.46	0.39	0.02	2.14	0.19
00/2348	54.583833	-1.1845	Cargo Fleet V	3.10	0.12	0.06	3.69	-0.40
00/2349	54.584667	-1.196167	Cargo Fleet V	6.42	0.33	0.01	2.13	0.24
00/2350	54.5875	-1.186667	No. 25 Buoy :	7.10	0.36	0.01	2.17	-0.33
00/2351	54.588167	-1.187667	No. 25 Buoy r	7.34	0.30	0.01	2.61	-0.38
00/2353	54.589167	-1.189667	No. 25 Buoy r	6.68	0.30	0.01	1.99	0.16
00/2352	54.597333	-1.173333	ICI North Tee	7.43	0.28	0.02	2.14	0.33

Kurtosis	% Gravel (>2mm)	% Sand (63-2mm)	% Silt/Clay (<63µm)
3.28	0.23	15.15	84.62
3.08	0.05	19.03	80.92
2.85	0.07	20.22	79.71
3.34	8.77	22.32	68.91
3.05	0.08	15.21	84.71
3.15	0.17	56.28	43.55
3.48	0.62	19.98	79.41
3.39	0.08	17.40	82.52
3.42	0.16	17.59	82.25
2.50	12.63	32.58	54.79
2.82	0.03	16.43	83.54
3.84	0.34	12.87	86.79
3.27	0.90	18.35	80.75
3.22	0.03	9.34	90.63
3.06	0.00	20.68	79.32

Annex 1.2 Particle size distribution and total organic carbon of Tees sediment samples

Tees Estuary (Tees Mouth & Tees Bay)

LSN	Latitude	Longitude	Location	Mean (phi)
00/2356	54.604667	-1.163333	ICI No.4 Buoy	6.19
00/2357	54.61	-1.155	Shell Oil jetty mid-channel	6.22
00/2358	54.6105	-1.159167	Shell Oil jetty north bank	6.16
00/2359	54.612667	-1.143333	Entrance to Dabholm Gut	4.60
00/2360	54.6195	-1.153333	East of No.15 buoy mid channel	6.67
00/2361	54.619833	-1.15	East of No.15 buoy south bank	5.85
00/2332	54.626167	-1.180833	Seal sands	2.88
00/2337	54.631167	-1.174167	Seaton-onTees	6.51
00/2338	54.631667	-1.155	Off Bran sands mid-channel	5.39
00/2702	54.686317	-1.150067	Tees Bay G6	2.95
00/2703	54.69405	-1.1203	Tees Bay G4	2.36
00/2362	54.663333	-1.171667	Tees Bay Off Seaton sands	
00/2363	54.656333	-1.163333	Tees Bay Off Seaton sands	
00/2704	54.6821	-1.0835	Tees Bay G1	2.22
00/2365	54.6485	-1.140833	R. Tees entrance No. 5 Buoy	3.17
00/2701	54.665267	-1.143217	Tees Bay G5	2.74
00/2700	54.6568	-1.114	Tees Bay G3	2.39
00/2705	54.6616	-1.083483	Tees Bay G2	3.05
00/2713	54.680367	-1.049783	Tees Bay Inshore disposal site C4	
00/2367	54.636333	-1.110667	Off Coatham sands	
00/2368	54.629167	-1.093	Off Coatham sands	
00/2706	54.673567	-1.027317	Tees Inshore disposal site C6	
00/2757	54.733183	-1.88305	NMMP 295 Off Tee's	

TOC	TON	Mean (mm)	Sorting	Skewness	Kurtosis	% Gravel (>2mm)	% Sand (63-2mm)	% Silt/Clay (<63μm)
6.47	0.32	0.01	2.07	0.34	2.84	0.00	15.37	84.63
6.29	0.30	0.01	2.21	0.08	3.25	0.15	13.36	86.49
5.87	0.25	0.01	2.19	0.19	2.67	0.00	17.60	82.40
10.25	0.77	0.04	2.51	0.32	3.28	2.75	40.60	56.65
7.14+6.99	0.3+0.28	0.01	2.18	0.14	2.47	0.00	11.69	88.31
7.17	0.37	0.02	2.03	0.56	3.11	0.00	17.39	82.61
0.66	0.02	0.14	2.54	0.79	5.09	3.88	75.24	20.88
6.26	0.16	0.01	2.23	0.15	2.51	0.02	13.76	86.21
7.47	0.26	0.02	2.41	0.60	2.51	0.02	36.10	63.89
0.52	<0.01	0.13	1.55	1.96	11.89	0.92	89.30	9.77
6.33+6.21	0.16+0.16	0.19	4.03	0.32	1.88	26.20	36.97	36.83
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
0.80	0.02	0.21	1.22	4.00	25.58	0.04	96.54	3.42
1.32	0.02	0.11	1.86	2.09	8.00	0.08	84.21	15.70
0.38	0.01	0.15	1.45	2.07	15.38	1.00	94.19	4.81
0.40	0.01	0.19	1.37	2.37	14.91	0.45	95.05	4.51
0.74	0.03	0.12	1.63	2.01	10.17	0.30	88.25	11.46
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA

Annex 1.3 Particle size distribution and TOC contents of other UK river sediments.

LSN	Latitude	Longitude	Location	TOC (%)	TON	Mean (mm)	Sorting	Skewness
00/3987	55.939	-4.655822	Clyde - Wood	1.4	0.11	0.65	2.41	0.66
00/3988	55.928333	-4.529667	Clyde - Milton	1.39	0.08	0.08	2.11	1.45
00/3989	55.923333	-4.465833	Clyde - Erskir	1.14	0.06	0.11	2.63	0.78
00/3990	55.905833	-4.436667	Clyde - Dalmı	2.19/1.98	0.11/0.08	0.13	2.49	0.78
00/2758	54.007167	1.999867	Humber	0.95				
00/2588	54.981633	-1.744383	R.Tyne at Newscastle					
00/2589	54.982033	-1.749017	R.Tyne at Newscastle					
00/2582	54.6089	-1.550467	R.Skern at He	1.1				
00/2583	54.606633	-1.55245	R.Skern at He	0.9				
00/2584	54.60095	-1.559717	Demons Becl	2.2				
00/2585	54.601717	-1.561683	Demons Becl	1.9				
00/2586	54.595617	-1.558467	R.Skern Hewı	0.35				
01/1417/1	53.472833	-3.255	Liverpool Bay	1.66				
01/1418/1	53.472	-3.256	Liverpool Bay	0.33				
01/1418/2	53.472	-3.256	Liverpool Bay	0.42				
01/1420/1	53.471467	-3.3509	Liverpool Bay	0.16				

Kurtosis	% Gravel (>2mm)	% Sand (63-2mm)	% Silt/Clay (<63μm)
5.00	23.59	69.77	6.65
4.49	0.00	70.45	29.55
3.61	3.28	67.57	29.14
3.95	4.23	70.15	25.62

Annex 1.4 Individual whiting lengths and weights (Tees food chain, WP 1)

Bulked LSN	Component I	Length	Whole weigh	Liver weight
2001/1095	1091	13.3	23.4	0.2
	1092	13.5	26	0.4
	1093	15	31.2	0.5
	1094	17.2	39	0.7
	Mean	**14.75**	**29.9**	**0.45**
2001/1104	1110	15	34.8	1
	1111	15.1	28.4	0.5
	1112	17.2	39.1	1.2
	Mean	**16.15**	**33.75**	**0.85**
2001/1113	1108	15.3	27.5	0.4
	1109	14.5	29.6	0.7
	1110	15	34.8	1
	1111	15.1	28.4	0.5
	1112	17.2	39.1	1.2
	Mean	**15.45**	**32.98**	**0.85**
2001/1120	1115	14.5	26.1	1.2
	1116	14.6	28.6	0.9
	1117	15	35.8	1.4
	1118	15.6	31.4	0.9
	1119	16.2	29	1
	Mean	**15.35**	**31.2**	**1.05**
2001/1127	1122	15	29.9	1
	1123	15.7	33.8	1.2
	1124	15.3	36.4	1.1
	1125	16.4	36.4	1.6
	1126	16	34	1.3
	Mean	**15.68**	**34.1**	**1.24**

Annex 1.5 Individual whiting lengths and weights (Tees food chain, WP 1)

Bulked LSN	Component I	Length	Whole weigh	Liver weight
2001/1134	1129	13.9	20.2	0.3
	1130	15.7	37.1	1.8
	1131	16.4	35.6	2.2
	1132	17	37	2
	1133	19.8	65	2.6
	Mean	**16.56**	**38.98**	**1.78**
2001/1141	1136	16.6	35.2	0.3
	1137	18	55.4	2.1
	1138	18	54.2	0.9
	1139	23.6	98	1.7
	1140	26	130.1	1.3
	Mean	**21.4**	**84.43**	**1.5**
2001/1147	1143	15.5	28.5	0.6
	1144	17.5	43.4	0.6
	1145	19.4	55.2	1
	1146	23.8	107.2	2
	Mean	**19.05**	**58.58**	**1.05**
2001/1155	1151	14.5	24.9	0.2
	1152	17.3	42.2	0.5
	1153	21.2	57.5	0.8
	1154	22	85.2	1.1
	Mean	**18.75**	**52.45**	**0.65**
2001/1162	1159	17	37.8	0.6
	1160	19.9	59.3	1.6
	1161	20.5	53.4	0.3
	Mean	**20.2**	**56.35**	**0.95**

Annex 1.6 Cormorant sample data (Tees food chain, WP 1)

LSN	Sex	Age	Date shot	County
99/2621	M	adult	30-11-1996	Monmouthshire
99/2622	M	adult	26-12-1996	Monmouthshire
99/2620	F	adult	17-01-1997	Hampshire
99/2625	M	adult	30-01-1997	Hampshire
99/2614	M	adult	31-01-1997	Lancashire
99/2623	M	adult	09-02-1997	Shropshire
99/2613	M	adult	12-02-1997	Warwickshire
99/2626	F	immature	17-02-1997	Cheshire
99/2610	F	adult	21-02-1997	Staffordshire
99/2612	M	adult	25-02-1997	Staffordshire
99/2600	M	immature	27-02-1997	Cumbria
99/2617	M	adult	02-03-1997	Shropshire
99/2624	F	adult	02-03-1997	Hampshire
99/2616	M	adult	05-03-1997	Staffordshire
99/2618	M	adult	14-03-1997	Hampshire
99/2602	M	adult	17-03-1997	Cumbria
99/2601	F	adult	26-03-1997	Cumbria
99/2619	M	immature	30-03-1997	Hampshire
99/2615	M	adult	31-03-1997	Monmouthshire
99/2627	M	adult	14-12-1997	Monmouthshire
00/2273	M	immature	26-07-1999	Kent
00/2272	M	adult	09-10-1999	Kent
00/2274	F	adult	10-10-1999	Kent
00/2248	M	adult	15-10-1999	Middlesex
00/2251	M	immature	17-10-1999	Hampshire
00/2250	M	adult	11-11-1999	Hampshire
00/2263	M	immature	17-11-1999	Lancashire
00/2270	M	immature	01-12-1999	Lancashire
00/2275	M	immature	05-12-1999	Kent
00/2253	F	adult	19-12-1999	Northumberland
00/2252	F	adult	23-12-1999	Hampshire
00/2265	M	immature	23-12-1999	Staffordshire
00/2262	M	immature	23-12-1999	Staffordshire
00/2269	F	adult	31-12-1999	Shropshire
00/2260	M	adult	02-01-2000	Surrey
00/2261	M	adult	02-01-2000	Surrey
00/2266	M	immature	08-01-2000	Lancashire
00/2268	F	immature	17-01-2000	Lancashire
00/2268	M	adult	19-01-2000	Lancashire
00/2254	M	immature	25-01-2000	Hampshire
00/2264	M	immature	26-01-2000	Hampshire
00/2258	F	immature	26-01-2000	Hampshire
00/2259	F	immature	27-01-2000	Hampshire
00/2256	M	adult	29-01-2000	Hampshire
00/2271	M	immature	29-01-2000	Staffordshire
00/2267	M	immature	31-01-2000	Warwickshire
00/2255	F	immature	03-02-2000	Sussex

Annex 1.7. Cormorant sampling areas

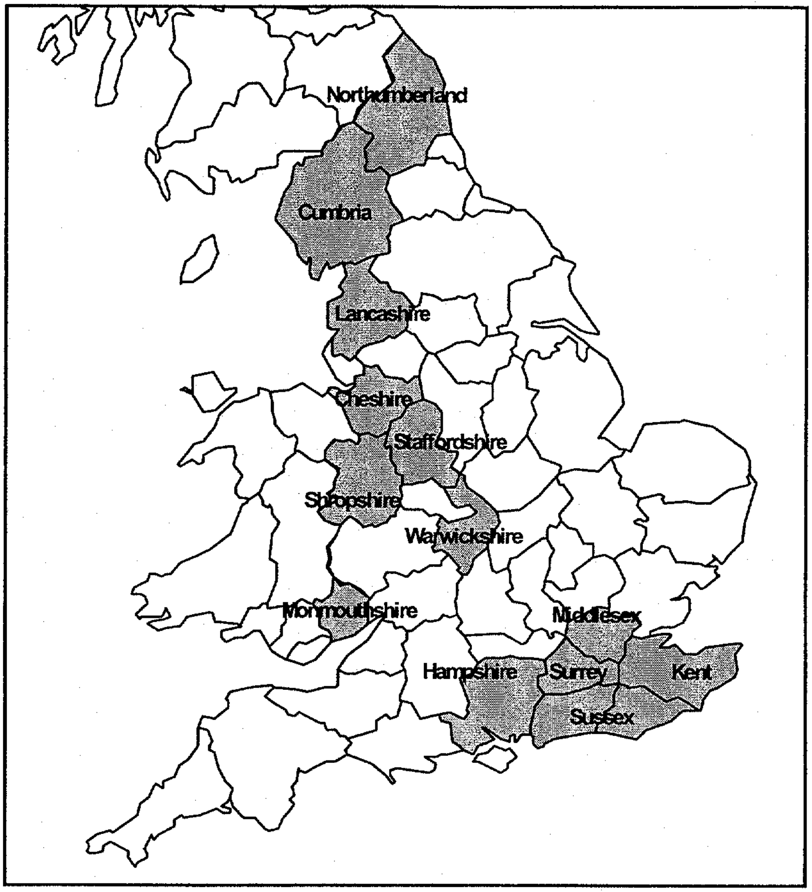
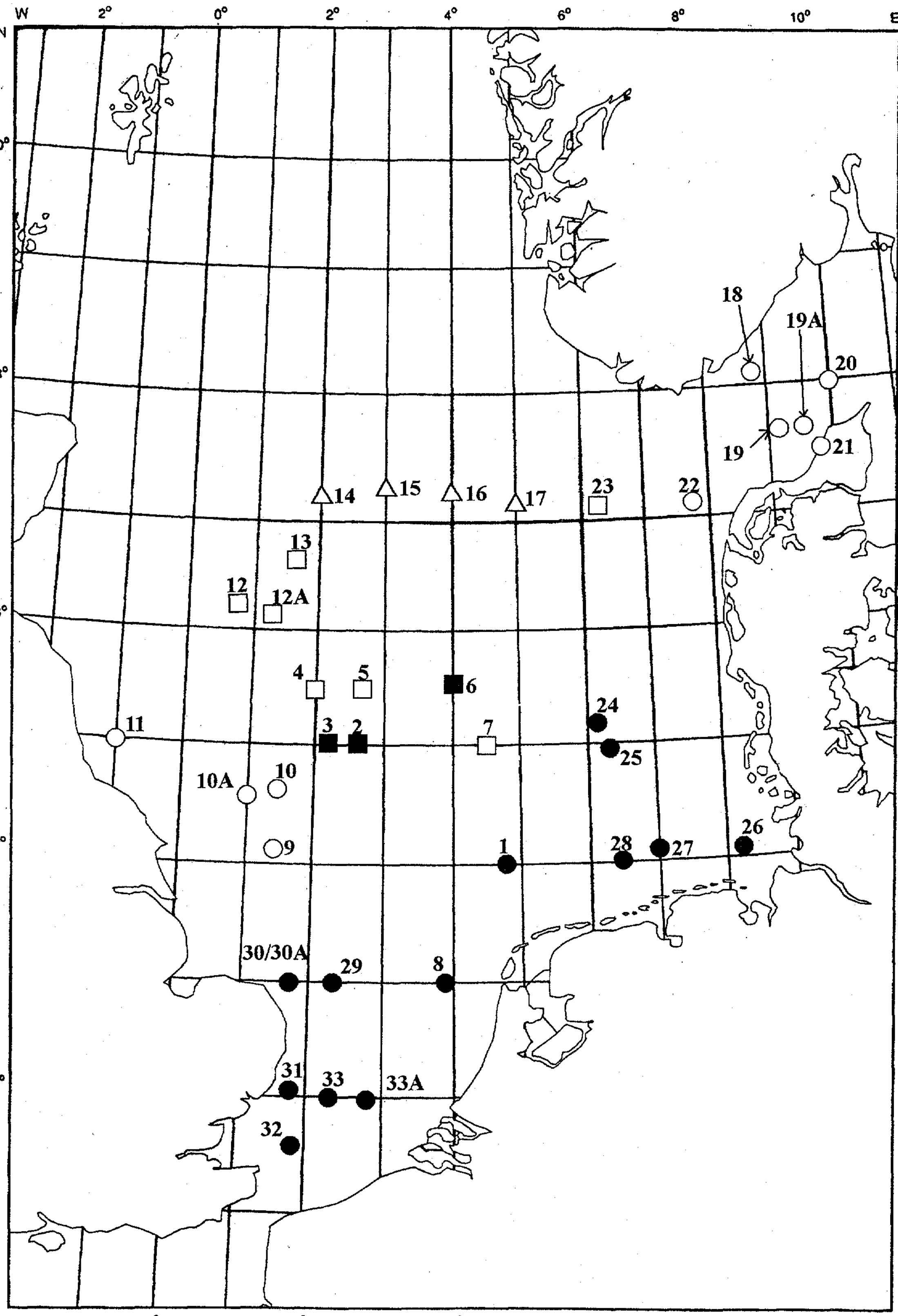


Figure 7. Cormorant Locations

Annex 1.8 Fishery locations



Annex 1.10

Various sample data WP 1, 2 and 5

Sample	Location	WP	Sampling date
Tern eggs	Terneuzen	1	Spring 1999
Tern eggs	Maasvlakte	1	Spring 1999
Mysid shrimp	Terneuzen	1	30-31/3/2000
Gudgeon	Terneuzen	1	30-31/3/2000
Greater sandeel	Terneuzen	1	30-31/3/2000
Yellow eel*	Dutch rivers	5	May/June 1999
Sediments	Dutch rivers	5	May/June 1999
Sediments	Western scheldt	2	June 1999
Cod liver**	North Sea	5	August 1999
Hake Liver	Atlantic Ocean	5	January 2001
Sediment***	Liffey, Ireland	5	11/11/1999

* all eel samples were pooled samples of 25 eels, in a length class of 30-40 cm; ** all cod and hake samples were pooled liver samples of cods and hakes in a length class of 40-50 cm; ***exact location: Liffey estuary near Poolbeg, Dublin, 53° 20′ 57‴ N, 6° 10′ 71″ W, depth 4m.

Annex 2.1. PBDE concentrations in North Sea food chain samples

Starfish *(Asteria rubens)*

BDE concentration in pg per g wet weight

Location:	10/02	11/01	12/01	14/01	19/02	23/02	25/01	33/02
BDE28	81	< 29	< 23	< 23	24	< 22	27	38
BDE75	< 22	< 29	< 23	< 23	< 22	< 22	< 19	< 21
BDE71	< 22	< 28	< 23	< 23	< 22	< 22	< 19	< 21
BDE47	4070	1180	115	1600	1370	410	500	570
BDE66	106	64	< 23	< 23	< 22	< 22	26	< 21
BDE77	24	< 28	< 23	< 23	< 22	< 22	< 19	< 21
BDE100	1060	2890	130	2900	560	300	170	280
BDE119	45	< 29	< 24	< 24	< 23	< 23	22	< 22
BDE99	494	1720	34	420	180	90	98	100
BDE85	< 23	< 30	< 24	< 24	< 23	< 23	< 20	< 22
BDE154	143	1440	< 24	51	< 23	< 23	34	52
BDE153	< 22	169	< 23	< 23	< 22	< 22	< 19	23
BDE138	23	< 28	< 23	< 23	42	< 22	< 19	< 21
BDE183	< 27	< 35	< 28	< 28	< 27	< 27	< 24	< 26
BDE190	< 29	< 37	< 30	< 30	< 29	< 29	< 25	< 27
BDE209	< 180	310	< 190	< 180	< 180	< 180	< 150	< 170

BDE concentration in ng per g lipid weight

Location:	10/02	11/01	12/01	14/01	19/02	23/02	25/01	33/02
BDE28	1.1	< 0.8	< 0.7	< 0.5	0.5	< 0.5	0.4	0.5
BDE75	< 0.3	< 0.8	< 0.7	< 0.5	< 0.5	< 0.5	< 0.3	< 0.3
BDE71	< 0.3	< 0.8	< 0.7	< 0.5	< 0.5	< 0.5	< 0.3	< 0.3
BDE47	55.7	33.7	3.4	34.1	29.2	8.7	6.7	7.5
BDE66	1.5	1.8	< 0.7	< 0.5	< 0.5	< 0.5	0.3	< 0.3
BDE77	0.3	< 0.8	< 0.7	< 0.5	< 0.5	< 0.5	< 0.3	< 0.3
BDE100	14.5	82.5	3.8	61.7	11.9	6.4	2.2	3.6
BDE119	0.6	< 0.8	< 0.7	< 0.5	< 0.5	< 0.5	0.3	< 0.3
BDE99	6.8	49.1	1.0	9.0	3.9	1.9	1.3	1.3
BDE85	< 0.3	< 0.8	< 0.7	< 0.5	< 0.5	< 0.5	< 0.3	< 0.3
BDE154	2.0	41.0	< 0.7	1.1	< 0.5	< 0.5	0.4	0.7
BDE153	< 0.3	4.8	< 0.7	< 0.5	< 0.5	< 0.5	< 0.3	0.3
BDE138	0.3	< 0.8	< 0.7	< 0.5	0.9	< 0.5	< 0.3	< 0.3
BDE183	< 0.4	< 1.0	< 0.8	< 0.6	< 0.6	< 0.6	< 0.3	< 0.3
BDE190	< 0.4	< 1.1	< 0.9	< 0.6	< 0.6	< 0.6	< 0.3	< 0.4
BDE209	< 2.4	8.9	< 5.4	< 3.9	< 3.8	< 3.8	< 2.0	< 2.2

Annex 2.2. PBDE concentrations in North Sea food chain samples

Hermit Crab (*Pagurus bernhardus*)

BDE concentration in pg per g wet weight

Location:	09/02	11/01	13/02	15/01	20/02	22/01	26/02	30/01	32/02
BDE28	120	112	< 31	86	< 21	< 23	< 20	231	114
BDE75	< 27	< 28	< 31	< 20	< 21	< 23	< 20	< 20	< 27
BDE71	< 26	< 27	< 30	< 20	< 21	< 22	< 20	< 20	< 27
BDE47	8740	4770	2110	3280	1480	1180	820	4410	2830
BDE66	178	168	< 30	110	< 21	< 23	< 20	210	130
BDE77	< 27	< 28	< 30	< 20	< 21	< 23	< 20	< 20	< 27
BDE100	2170	2680	1450	1700	620	390	270	1520	1090
BDE119	< 27	< 28	< 31	< 20	< 21	< 23	< 21	< 21	< 28
BDE99	1090	4730	1200	689	535	513	163	2530	906
BDE85	< 28	< 29	< 32	< 20	< 22	< 23	< 21	< 21	< 28
BDE154	520	3750	420	270	250	130	140	1170	510
BDE153	168	1190	189	146	85	78	< 20	368	150
BDE138	< 26	< 27	< 30	< 20	< 21	< 22	< 20	< 20	< 27
BDE183	< 33	< 34	< 37	< 24	< 26	< 28	< 25	< 25	< 34
BDE190	< 35	< 36	< 40	< 26	< 27	< 29	< 27	< 26	< 36
BDE209	300	470	< 240	< 160	< 170	< 180	< 160	< 160	< 220

BDE concentration in ng per g lipid weight

Location:	09/02	11/01	13/02	15/01	20/02	22/01	26/02	30/01	32/02
BDE28	1.6	1.7	< 0.4	0.8	< 0.2	< 0.3	< 0.2	1.6	1.2
BDE75	< 0.4	< 0.4	< 0.4	< 0.2	< 0.2	< 0.3	< 0.2	< 0.1	< 0.3
BDE71	< 0.4	< 0.4	< 0.4	< 0.2	< 0.2	< 0.3	< 0.2	< 0.1	< 0.3
BDE47	120	71	25	31	16	16	8.6	31	29
BDE66	2.4	2.5	< 0.4	1.0	< 0.2	< 0.3	< 0.2	1.5	1.3
BDE77	< 0.4	< 0.4	< 0.4	< 0.2	< 0.2	< 0.3	< 0.2	< 0.1	< 0.3
BDE100	29.3	40.0	17.0	16.0	6.9	5.3	2.8	10.8	11.1
BDE119	< 0.4	< 0.4	< 0.4	< 0.2	< 0.2	< 0.3	< 0.2	< 0.1	< 0.3
BDE99	15	71	14	6.5	5.9	7.0	1.7	18	9.2
BDE85	< 0.4	< 0.4	< 0.4	< 0.2	< 0.2	< 0.3	< 0.2	< 0.1	< 0.3
BDE154	7.0	56.0	5.0	2.6	2.7	1.8	1.5	8.3	5.2
BDE153	2.3	17.7	2.2	1.4	0.9	1.1	< 0.2	2.6	1.5
BDE138	< 0.4	< 0.4	< 0.4	< 0.2	< 0.2	< 0.3	< 0.2	< 0.1	< 0.3
BDE183	< 0.4	< 0.5	< 0.4	< 0.2	< 0.3	< 0.4	< 0.3	< 0.2	< 0.3
BDE190	< 0.5	< 0.5	< 0.5	< 0.2	< 0.3	< 0.4	< 0.3	< 0.2	< 0.4
BDE209	4.1	7.0	< 2.9	< 1.5	< 1.8	< 2.5	< 1.7	< 1.1	< 2.2

Annex 2.3. PBDE concentrations in North Sea food chain samples

Whelk *(Buccinum undatum)*

BDE concentration in pg per g wet weight

Location:	9/04	10/01	12/01	16/01	21/01	26/02	31/02
BDE28	23	< 10	25	15	< 24	16	28
BDE75	< 7	< 10	< 7	< 7	< 24	20	< 7
BDE71	< 7	< 10	< 7	< 7	< 24	< 14	< 7
BDE47	390	130	450	170	71	44	75
BDE66	< 7	< 10	10	< 7	< 24	< 15	< 7
BDE77	< 7	< 10	< 7	< 7	< 24	< 15	< 7
BDE100	120	38	146	42	< 25	< 15	41
BDE119	26	< 10	20	11	< 25	< 15	< 8
BDE99	160	90	260	69	68	50	110
BDE85	< 7	< 10	< 7	< 7	< 25	< 15	< 8
BDE154	150	< 10	30	< 7	< 25	< 15	< 8
BDE153	320	97	130	68	99	29	310
BDE138	65	< 10	< 7	< 7	30	< 14	50
BDE183	< 8	< 12	< 8	< 8	< 30	< 18	< 9
BDE190	< 9	< 13	< 9	< 9	< 32	< 19	< 10
BDE209	< 54	< 77	< 54	< 52	< 190	120	< 59

BDE concentration in ng per g lipid weight

Location:	9/04	10/01	12/01	16/01	21/01	26/02	31/02
BDE28	1.0	< 0.7	1.6	1.0	< 1.7	< 1.0	1.0
BDE75	< 0.3	< 0.6	< 0.4	< 0.2	< 1.7	1.2	< 0.5
BDE71	< 0.3	< 0.6	< 0.4	< 0.2	< 1.7	< 1.0	< 0.5
BDE47	16	5.5	30	11	4.2	2.6	2.8
BDE66	< 0.3	< 0.6	0.7	< 0.2	< 1.7	< 1.0	< 0.5
BDE77	< 0.3	< 0.6	< 0.4	< 0.2	< 1.7	< 1.0	< 0.5
BDE100	5.2	1.6	9.7	2.8	< 1.8	< 1.0	1.5
BDE119	1.1	< 0.7	1.3	0.8	< 1.8	< 1.0	< 0.5
BDE99	6.6	3.7	17	4.6	4.0	2.9	4.0
BDE85	< 0.3	< 0.7	< 0.4	< 0.3	< 1.8	< 1.0	< 0.5
BDE154	6.3	< 0.7	2.0	< 0.3	< 1.8	< 1.0	< 0.5
BDE153	14	4.1	8.6	4.6	5.8	1.7	12
BDE138	2.7	< 0.6	< 0.4	< 0.2	1.8	< 1.0	1.9
BDE183	< 0.3	< 0.8	< 0.5	< 0.3	< 2.1	< 1.2	< 0.6
BDE190	< 0.4	< 0.8	< 0.5	< 0.3	< 2.3	< 1.3	< 0.6
BDE209	< 2.3	< 5.2	< 3.2	< 1.9	< 14	< 7.7	< 3.7

Annex 2.4. PBDE concentrations in North Sea food chain samples

Shrimp *(Crangon almanii)*

BDE concentration in pg per g wet weight

Location:	30/01	31/02
BDE28	91	31
BDE75	< 10	< 9
BDE71	< 10	< 9
BDE47	1310	460
BDE66	140	< 9
BDE77	< 10	< 9
BDE100	290	66
BDE119	< 10	< 9
BDE99	180	60
BDE85	< 11	< 10
BDE154	130	< 10
BDE153	< 10	< 9
BDE138	< 10	< 9
BDE183	< 12	< 11
BDE190	< 13	< 12
BDE209	< 81	< 73

BDE concentration in ng per g lipid weight

Location:	30/01	31/02
BDE28	2.7	2.4
BDE75	< 0.3	< 0.7
BDE71	< 0.3	< 0.7
BDE47	39	35
BDE66	4.0	< 0.7
BDE77	< 0.3	< 0.7
BDE100	8.7	5.1
BDE119	< 0.3	< 0.7
BDE99	5.5	4.6
BDE85	< 0.3	< 0.7
BDE154	3.9	< 0.7
BDE153	< 0.3	< 0.7
BDE138	< 0.3	< 0.7
BDE183	< 0.4	< 0.9
BDE190	< 0.4	< 0.9
BDE209	< 2.4	< 5.6

Annex 2.5. PBDE concentrations in North Sea food chain samples

Herring liver *(Clupea haringus)*

BDE concentration in pg per g wet weight

Location:	CH01L	CH02L	CH03L	CH04L
BDE28	< 41	< 66	94	170
BDE75	< 41	< 66	< 49	< 38
BDE71	< 40	< 65	< 49	< 38
BDE47	780	2480	1080	1750
BDE66	< 40	< 65	< 49	154
BDE77	< 40	< 65	< 49	< 38
BDE100	230	820	320	440
BDE119	< 41	< 67	< 50	< 39
BDE99	402	1010	460	760
BDE85	< 42	< 68	< 51	< 40
BDE154	58	210	< 51	97
BDE153	40	190	< 49	75
BDE138	< 40	< 65	< 49	< 38
BDE183	< 50	< 80	< 60	< 47
BDE190	< 53	< 85	< 64	< 50
BDE209	< 320	< 520	< 390	< 300

BDE concentration in ng per g lipid weight

Location:	CH01L	CH02L	CH03L	CH04L
BDE28	< 1.3	< 1.4	1.7	2.5
BDE75	< 1.3	< 1.4	< 0.9	< 0.6
BDE71	< 1.3	< 1.4	< 0.9	< 0.6
BDE47	24	52	19	27
BDE66	< 1.3	< 1.3	< 0.9	2.33
BDE77	< 1.3	< 1.3	< 0.9	< 0.58
BDE100	7.2	17	5.6	6.7
BDE119	< 1.3	< 1.4	< 0.88	< 0.59
BDE99	13	21	8.0	12
BDE85	< 1.3	< 1.4	< 0.9	< 0.6
BDE154	1.8	4.4	< 0.9	1.5
BDE153	1.3	3. 9	< 0.9	1.1
BDE138	< 1.3	< 1.4	< 0.9	< 0.6
BDE183	< 1.5	< 1.7	< 1.1	< 0.7
BDE190	< 1.7	< 1.8	< 1.1	< 0.8
BDE209	< 10	< 11	< 7.0	< 4.6

Annex 2.6. PBDE concentrations in North Sea food chain samples

Herring fillet

BDE concentration in pg per g wet weight

Location:	CH01F	CH02F	CH03F	CH04F
BDE28	285	220	190	210
BDE75	< 20	< 28	< 27	< 31
BDE71	< 20	< 27	< 26	< 31
BDE47	5130	4360	3440	4420
BDE66	320	230	230	290
BDE77	< 20	< 27	< 27	< 31
BDE100	1210	1100	958	1125
BDE119	< 21	< 28	< 27	< 31
BDE99	1493	1303	1490	1650
BDE85	< 21	< 29	< 28	< 32
BDE154	180	190	190	180
BDE153	110	94	86	123
BDE138	< 20	< 27	< 26	< 31
BDE183	< 25	< 34	< 33	< 38
BDE190	< 27	< 36	< 35	< 40
BDE209	<160	< 220	< 210	< 250

BDE concentration in ng per g lipid weight

Location:	CH01F	CH02F	CH03F	CH04F
BDE28	2.4	1. 7	1.3	2.2
BDE75	< 0.2	< 0.2	< 0.2	< 0.3
BDE71	< 0.2	< 0.2	< 0.2	< 0.3
BDE47	43	34	23	47
BDE66	2.7	1.8	1.5	3.0
BDE77	< 0.2	< 0.2	< 0.2	< 0.3
BDE100	10	8.5	6.3	12
BDE119	< 0.2	< 0.2	< 0.2	< 0.3
BDE99	13	10	9.9	17
BDE85	< 0.2	< 0.2	< 0.2	< 0.3
BDE154	1.5	1.4	1.3	1.9
BDE153	0.92	0.73	0.57	1.3
BDE138	< 0.2	< 0.2	< 0.2	< 0.3
BDE183	< 0.2	< 0.3	< 0.2	< 0.4
BDE190	< 0.2	< 0.3	< 0.2	< 0.4
BDE209	< 1.4	< 1.7	< 1.4	< 2.6

Annex 2.7. PBDE concentrations in North Sea food chain samples

Herring milt and eggs

BDE concentration in pg per g wet weight

Location:	CH01E	CH03E	CH02M	CH04M
BDE28	89	54	< 25	< 25
BDE75	< 16	< 16	< 25	< 24
BDE71	< 16	< 16	< 25	< 24
BDE47	950	680	280	390
BDE66	69	61	< 25	< 24
BDE77	< 16	< 16	< 25	< 24
BDE100	270	170	78	140
BDE119	< 17	< 16	< 25	< 25
BDE99	410-	340	120	170
BDE85	< 17	< 16	< 26	< 25
BDE154	58	42	< 26	< 26
BDE153	40	< 16	< 25	< 24
BDE138	< 16	< 16	< 25	< 24
BDE183	< 20	< 19	< 30	< 30
BDE190	< 21	< 20	< 32	< 32
BDE209	< 130	< 130	< 200	< 200

BDE concentration in ng per g lipid weight

Location:	CH01E	CH03E	CH02M	CH04M
BDE28	1.4	0.84	< 0.4	< 0.63
BDE75	< 0.3	< 0.2	< 0.4	< 0.6
BDE71	< 0.3	< 0.2	< 0.4	< 0.6
BDE47	15	10	4.5	10
BDE66	1.10	0.93	< 0.4	< 0.6
BDE77	< 0.3	< 0.2	< 0.4	< 0.6
BDE100	4.3	2.7	1.2	3.5
BDE119	< 0.3	< 0.2	< 0.4	< 0.6
BDE99	6.4	5.2	1.9	4.4
BDE85	< 0.3	< 0.3	< 0.4	< 0.7
BDE154	0.91	0.64	< 0.4	< 0.7
BDE153	0.64	< 0.2	< 0.4	< 0.6
BDE138	< 0.3	< 0.2	< 0.4	< 0.6
BDE183	< 0.3	< 0.3	< 0.5	< 0.8
BDE190	< 0.3	< 0.3	< 0.5	< 0.8
BDE209	< 2.1	< 1.9	< 3.1	< 5.0

Annex 2.8. PBDE concentrations in North Sea food chain samples

Cod liver *(Gadus morhua)*

BDE concentration in pg per g wet weight

compound	10/02	12/01	14/02	21/01	23/01	33/01
BDE28	3390	2180	4110	300	2120	< 46
BDE75	190	160	270	< 39	180	< 46
BDE71	< 14	< 14	< 35	< 39	< 38	< 45
BDE47	57700	46800	68000	9470	53500	570
BDE66	2520	1400	2720	150	880	< 45
BDE77	160	86	73	79	< 38	< 45
BDE100	10300	15200	23400	2650	16100	240
BDE119	440	270	400	89	250	< 47
BDE99	2250	4130	6690	200	1620	360
BDE85	< 14	< 14	< 36	< 40	< 40	< 47
BDE154	2500	2190	2830	640	2150	< 48
BDE153	280	240	360	99	230	< 45
BDE138	35	< 14	200	85	180	300
BDE183	< 17	< 17	< 43	< 47	< 47	310
BDE190	< 18	< 18	< 46	< 50	< 50	< 59
BDE209	< 110	< 110	< 280	380	< 310	< 360

BDE concentration in ng per g lipid weight

Location:	10/02	12/01	14/02	21/01	23/01	33/01
BDE28	8.8	4.4	6.3	2.0	12	< 6.6
BDE75	0.49	0.32	0.41	< 0.26	1.02	< 6.6
BDE71	< 0.04	< 0.03	< 0.05	< 0.26	< 0.22	< 6.6
BDE47	150	94	100	63	310	83
BDE66	6.6	2.8	4.1	0.99	5.1	< 6.6
BDE77	0.42	0.17	0.11	0.52	< 0.22	< 6.6
BDE100	27	30	36	18	93	35
BDE119	1.1	0.54	0.61	0.59	1.4	< 6.7
BDE99	5.9	8.3	10	1.4	9.3	53
BDE85	< 0.04	< 0.03	< 0.06	< 0.27	< 0.23	< 6.9
BDE154	6.5	4.4	4.3	4.3	12	< 6.9
BDE153	0.72	0.49	0.55	0.66	1.3	< 6.6
BDE138	0.09	< 0.03	0.30	0.57	1.04	43
BDE183	< 0.04	< 0.03	< 0.07	< 0.32	< 0.27	45
BDE190	< 0.05	< 0.04	< 0.07	< 0.34	< 0.29	< 8.6
BDE209	< 0.29	< 0.22	< 0.42	2.5	< 1.8	< 53

Annex 2.9. PBDE concentrations in North Sea food chain samples

Cod fillet

BDE concentration in pg per g wet weight

Location:	10/02	12/01	14/02	21/01	22/01	23/01	33/01
BDE28	9	15	< 7	< 6	< 21	23	< 16
BDE75	< 7	< 8	< 7	< 6	< 21	< 6	< 16
BDE71	< 7	< 8	< 7	< 6	< 21	< 6	< 15
BDE47	170	180	220	170	230	370	230
BDE66	< 7	< 8	< 7	< 6	< 21	< 6	< 16
BDE77	< 7	< 8	< 7	< 6	< 21	< 6	< 16
BDE100	35	75	86	56	75	110	63
BDE119	< 7	< 8	< 7	< 7	< 21	< 6	< 16
BDE99	21	22	27	< 6	98	27	< 15
BDE85	< 7	< 8	< 7	< 7	< 22	< 6	< 16
BDE154	< 7	< 8	< 7	< 7	< 22	19	< 16
BDE153	< 7	< 8	< 7	< 6	< 21	< 6	< 16
BDE138	< 7	< 8	< 7	< 6	< 21	< 6	< 15
BDE183	< 8	< 10	< 8	< 8	< 26	< 8	< 19
BDE190	< 9	< 10	< 9	< 8	< 27	< 8	< 20
BDE209	< 53	< 63	< 53	< 51	< 170	< 49	< 120

BDE concentration in ng per g lipid weight

Location:	10/02	12/01	14/02	21/01	22/01	23/01	33/01
BDE28	1.5	2.1	< 1.0	< 1.1	< 3.3	4.5	< 5.0
BDE75	< 1.1	< 1.1	< 1.0	< 1.1	< 3.3	< 1.2	< 5.0
BDE71	< 1.1	< 1.1	< 1.0	< 1.1	< 3.3	< 1.2	< 5.0
BDE47	29	26	34	29	37	74	74
BDE66	< 1.1	< 1.1	< 1.0	< 1.1	< 3.3	< 1.2	< 5.0
BDE77	< 1.1	< 1.1	< 1.0	< 1.1	< 3.3	< 1.2	< 5.0
BDE100	5.9	11	13	9.8	12	21	20
BDE119	< 1.1	< 1.1	< 1.0	< 1.2	< 3.4	< 1.3	< 5.1
BDE99	3.6	3.1	4.1	< 1.1	16	5.3	< 5.0
BDE85	< 1.2	< 1.2	< 1.1	< 1.2	< 3.5	< 1.3	< 5.2
BDE154	< 1.2	< 1.2	< 1.1	< 1.2	< 3.5	3.9	< 5.2
BDE153	< 1.1	< 1.1	< 1.0	< 1.1	< 3.3	< 1.2	< 5.0
BDE138	< 1.1	< 1.1	< 1.0	< 1.1	< 3.3	< 1.2	< 5.0
BDE183	< 1.4	< 1.4	< 1.2	< 1.4	< 4.1	< 1.5	< 6.1
BDE190	< 1.5	< 1.5	< 1.3	< 1.5	< 4.3	< 1.6	< 6.5
BDE209	< 8.9	< 8.9	< 8.1	< 9.0	< 27	< 9.8	< 40

Annex 2.10. PBDE concentrations in North Sea food chain samples

Whiting liver *(Merlangius merlangus)*

BDE concentration in pg per g wet weight

Location:	09/01	11/01	16/01	21/02	26/01	31/01
BDE28	3100	3820	1590	890	320	2550
BDE75	390	340	290	< 35	180	500
BDE71	< 75	< 76	< 60	< 34	< 37	< 68
BDE47	53300	86000	27660	15880	3510	58970
BDE66	3530	5080	1910	840	170	2460
BDE77	< 75	220	< 60	100	50	120
BDE100	10460	20140	6700	3280	800	13590
BDE119	464	575	214	139	< 38	350
BDE99	11750	22450	6390	3180	880	9800
BDE85	< 78	< 79	< 62	< 36	< 39	< 70
BDE154	3370	7030	1410	720	280	2940
BDE153	990	2020	460	250	120	970
BDE138	< 75	< 76	< 60	44	238	< 68
BDE183	< 92	300	< 73	< 42	74	< 83
BDE190	< 98	< 100	< 78	< 45	< 48	< 89
BDE209	< 600	< 610	< 480	< 280	< 300	< 540

BDE concentration in ng per g lipid weight

Location:	09/01	11/01	16/01	21/02	26/01	31/01
BDE28	6.3	5.9	2.2	1.3	0.7	4.9
BDE75	0.8	0.5	0.4	< 0.1	0.4	1.0
BDE71	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
BDE47	110	130	39	23	7.6	110
BDE66	7.2	7.8	2.7	1.2	0.4	4.7
BDE77	< 0.2	0.3	< 0.1	0.1	0.1	0.2
BDE100	21	31	9.5	4.8	1.7	26
BDE119	0.9	0.9	0.3	0.2	< 0.1	0.7
BDE99	24	34	9.0	4.6	1.9	19
BDE85	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
BDE154	6.9	11	2.0	1.1	0.6	5.6
BDE153	2.0	3.1	0.6	0.4	0.3	1.8
BDE138	< 0.2	< 0.1	< 0.1	0.1	0.5	< 0.1
BDE183	< 0.2	0.5	< 0.1	< 0.1	0.2	< 0.2
BDE190	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2
BDE209	< 1.2	< 0.9	< 0.7	< 0.4	< 0.6	< 1.0

Annex 2.11. PBDE concentrations in North Sea food chain samples

Whiting filet

BDE concentration in pg per g wet weight

Location:	09/01	11/01	16/01	21/02	26/01	31/01
BDE28	9	15	< 5	< 10	< 7	< 7
BDE75	< 7	< 6	< 5	< 10	< 7	< 7
BDE71	< 7	< 6	< 5	< 10	< 7	< 7
BDE47	280	230	94	120	37	190
BDE66	< 7	< 6	< 5	< 10	< 7	< 7
BDE77	< 7	< 6	< 5	< 10	< 7	< 7
BDE100	78	63	27	33	< 7	61
BDE119	< 7	< 6	< 5	< 10	< 7	< 7
BDE99	68	86	34	38	< 7	50
BDE85	< 7	< 6	< 5	< 10	< 7	< 7
BDE154	15	27	< 5	< 10	< 7	< 7
BDE153	< 7	< 6	< 5	< 10	< 7	< 7
BDE138	< 7	< 6	< 5	< 10	< 7	< 7
BDE183	< 9	< 7	< 6	< 12	< 8	< 9
BDE190	< 9	< 8	< 7	< 13	< 9	< 9
BDE209	< 57	< 47	< 42	< 78	< 55	< 56

BDE concentration in ng per g lipid weight

Location:	09/01	11/01	16/01	21/02	26/01	31/01
BDE28	1.3	2.4	< 0.8	< 1.7	< 1.3	< 1.4
BDE75	< 1.0	< 1.0	< 0.8	< 1.7	< 1.3	< 1.4
BDE71	< 1.0	< 0.9	< 0.8	< 1.6	< 1.3	< 1.3
BDE47	40	37	15	21	7.1	36
BDE66	< 1.0	< 0.9	< 0.8	< 1.6	< 1.3	< 1.4
BDE77	< 1.0	< 0.9	< 0.8	< 1.6	< 1.3	< 1.4
BDE100	11	10	4.2	5.5	< 1.4	12
BDE119	< 1.0	< 1.0	< 0.8	< 1.7	< 1.4	< 1.4
BDE99	9.7	14	5.3	6.4	< 1.3	9.6
BDE85	< 1.1	< 1.0	< 0.8	< 1.7	< 1.4	< 1.4
BDE154	2.2	4.4	< 0.9	< 1.7	< 1.4	< 1.4
BDE153	< 1.0	< 0.9	< 0.8	< 1.6	< 1.3	< 1.4
BDE138	< 1.0	< 0.9	< 0.8	< 1.6	< 1.3	< 1.3
BDE183	< 1.3	< 1.2	< 1.0	< 2.0	< 1.6	< 1.7
BDE190	< 1.3	< 1.2	< 1.1	< 2.2	< 1.7	< 1.8
BDE209	< 8.2	< 7.6	< 6.5	< 13	< 11	< 11

Annex 2.12. PBDE concentrations in North Sea food chain samples

Harbour Porpoises *(Phocoena phocoena)*

Liver: BDE concentration in ng per g lipid weight

No.:	990322-1	990322-2	990322-3	990322-4	990322-5	981024-4
BDE28	9.8	5.0	17	22	18	86
BDE75	< 0.2	0.2	< 0.3	< 0.9	< 0.8	98
BDE71	< 0.2	< 0.1	< 0.4	< 0.9	< 0.8	< 0.6
BDE47	360	1	700	1300	740	4880
BDE66	< 0.2	< 0.1	< 0.4	< 0.9	< 0.8	96.3
BDE77	3.5	1.8	17	17	7.7	10
BDE100	87	0.3	250	570	320	2140
BDE119	< 0.2	< 0.1	< 0.4	< 1.0	0.0	29
BDE99	87	0.5	420	900	390	2490
BDE85	< 0.2	< 0.1	< 0.4	< 1.0	< 0.8	< 0.7
BDE154	33	0.2	440	330	120	1050
BDE153	15	0.1	370	170	51	500
BDE138	4.6	2.2	27	6.0	0.0	6.8
BDE183	< 0.2	< 0.1	< 0.5	< 1.1	< 1.0	< 0.8
BDE190	< 0.2	< 0.1	< 0.6	< 1.2	< 1.1	< 0.8
BDE209	< 1.4	1.2	< 2.7	< 7.4	< 6.5	6.3

Blubber: BDE concentration in ng per g lipid weight

No.:	981120-2	990322-4	981120-1	980325-2	981024-2	990322-1	990322-3	951031-1	951120-1
BDE28	23	18	29	21	19	7.6	25	36	17
BDE75	11	2.9	7.9	32	17	3.1	63	31	3.3
BDE71	< 1.5	< 2.4	< 1.3	< 0.1	< 0.2	< 0.3	< 0.3	< 1.4	< 1.7
BDE47	1180	780	1080	1190	690	250	1310	800	500
BDE66	15	50	38	9.9	8.5	5.0	17	13	23
BDE77	6.1	1.9	3.4	20.4	9.4	1.9	21.7	< 1.4	< 1.7
BDE100	190	300	230	370	170	47	480	240	150
BDE119	2.9	2.8	7.3	3.9	2.0	1.0	5.8	2.3	2.8
BDE99	350	540	310	500	340	43	760	510	300
BDE85	< 1.6	< 2.5	< 1.3	< 0.1	< 0.2	< 0.3	< 0.3	< 1.5	< 1.8
BDE154	44.0	150	100	240	75	13	800	150	35
BDE153	27	91	60	160	54	6	770	150	28
BDE138	3.2	1.6	4.7	22.7	6.2	1.6	37	25	8.5
BDE183	< 1.8	< 2.9	< 1.6	< 0.1	< 0.2	< 0.3	< 0.3	< 1.7	< 2.1
BDE190	< 1.9	< 3.1	< 1.7	< 0.1	< 0.2	< 0.3	< 0.3	< 1.8	< 2.3
BDE209	17	12	8.1	26	< 2.7	<3.0	6.0	< 11	< 14

Annex 2.13. PBDE concentrations in North Sea food chain samples

Harbour Seal *(Phoca vitulina)*

Liver: BDE concentration in ng per g lipid weight

No.:	01PVc	01PVa	96PVb	95HGa**	96PVa	96PVd
BDE28	< 1.2	< 0.9	28	< 1.7	4.1	< 5.4
BDE75	17	< 0.9	130	< 1.7	< 0.8	84
BDE71	< 1.2	< 0.9	< 1.0	< 1.7	< 0.8	< 5.3
BDE47	420	95	5070	190	320	1880
BDE66	< 1.2	< 0.9	< 1.1	< 1.7	< 0.8	< 5.3
BDE77	< 1.2	< 0.9	5.6	< 1.7	4.1	< 5.3
BDE100	21	8.7	270	16	24	160
BDE119	< 1.2	< 1.0	< 1.1	< 1.7	< 0.8	< 5.4
BDE99	32	29	1580	39	38	1010
BDE85	< 1.3	< 1.0	< 1.1	< 1.8	< 0.8	< 5.5
BDE154	14	2.6	52	21	11	160
BDE153	27	7.5	580	17	9.5	690
BDE138	22	17	33	130	26	57
BDE183	< 1.5	< 1.1	< 1.3	< 2.1	< 1.0	< 6.5
BDE190	< 1.6	< 1.2	< 1.4	< 2.2	< 1.1	< 7.0
BDE209	160	< 7.5	< 8.4	< 9.0	< 6.5	< 46

Blubber: BDE concentration in ng per g lipid weight

No.:	96PVb	PV 1553	96PVa	96PVc	01PVa	01PVb	PV 1452	PV 1544	PV 1349
BDE28	49	< 0.3	8.3	3.5	2.9	1.9	1.1	< 0.3	1.7
BDE75	190	0.9	< 0.2	< 0.3	0.3	5.8	< 0.3	5.2	6.5
BDE71	< 0.5	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.3	< 0.3	< 0.3
BDE47	9250	57	660	200	64	300	80	210	300
BDE66	< 0.5	< 0.3	< 0.2	< 0.3	2.2	< 0.3	< 0.3	< 0.3	< 0.3
BDE77	6.9	< 0.3	1.4	< 0.3	1.7	1.3	< 0.3	< 0.3	< 0.3
BDE100	540	6.2	63	16	11	32	7.8	25	30
BDE119	< 0.5	< 0.3	< 0.2	< 0.4	< 0.2	< 0.3	< 0.3	< 0.3	< 0.3
BDE99	3070	11	57	180	28	76	38	48	68
BDE85	7.2	< 0.3	< 0.2	< 0.4	< 0.2	0.2	< 0.3	< 0.3	< 0.3
BDE154	83	3.1	19	45	2.9	6.5	2.4	21	7.9
BDE153	720	9.9	9.4	42	3.4	23	6.2	36	33
BDE138	15	18	0.6	14	0.8	2.3	< 0.3	19	21
BDE183	< 0.6	< 0.4	< 0.3	2.5	< 0.3	< 0.3	< 0.4	25	3.7
BDE190	< 0.6	< 0.4	< 0.3	< 0.5	< 0.3	< 0.4	< 0.4	< 0.4	< 0.4
BDE209	< 3.8	< 2.6	5.5	< 2.8	< 1.8	< 2.5	< 1.9	< 2.1	16

Annex 2.14. PBDE concentrations in North Sea food chain samples

Dolphins

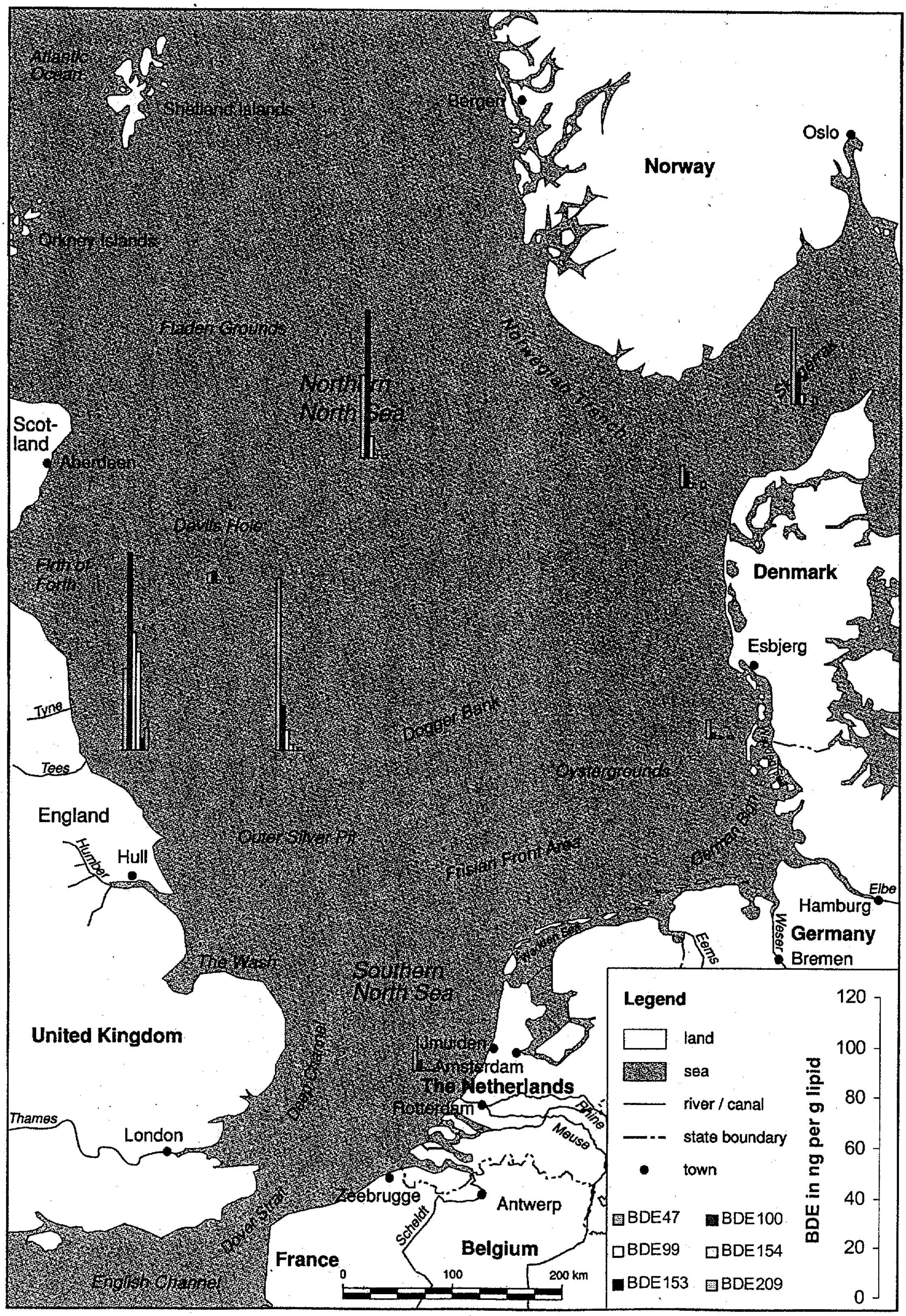
Whitebeaked Dolphins *(Lagenorynchus albirostris)* BDE concentration in ng per g lipid weight

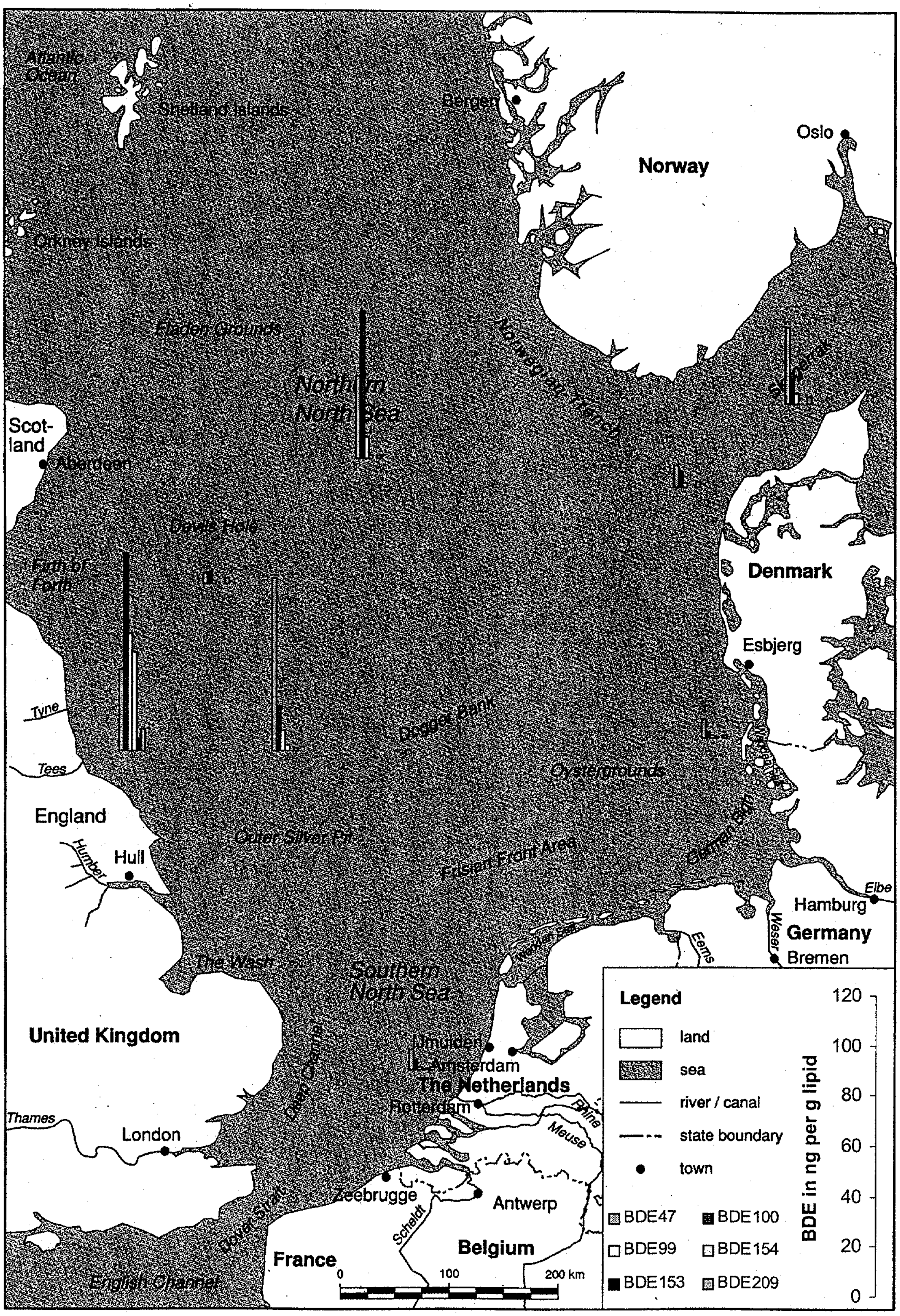
Species:	LaLSH014						LALSH 24/1/'95
Organ:	**Blubber**	**Liver**	**Kidney**	**Heart**	**Lungs**	**Brains**	**Liver**
BDE28	360	310	130	89	170	35	5.3
BDE75	< 0.5	210	30	12	< 1.6	38	< 1.5
BDE71	< 0.5	< 1.0	< 0.8	< 0.7	< 1.5	< 0.1	< 1.5
BDE47	24400	27900	18900	17100	28500	4620	280
BDE66	180	220	96	85	150	26	8.3
BDE77	10	27	23	21	33	5.1	< 1.5
BDE100	6330	10800	8640	7980	11800	2120	125
BDE119	34	< 1.0	48	39	68	13	< 1.5
BDE99	5540	10600	8020	6910	10700	2010	130
BDE85	< 0.5	< 1.1	< 0.8	< 0.7	< 1.6	< 0.1	< 1.6
BDE154	870	2700	2350	1950	3150	540	43
BDE153	140	910	750	640	990	220	17
BDE138	4.8	15	13	11	21	2.2	7.1
BDE183	< 0.6	< 1.2	13	27	38	< 0.1	< 1.8
BDE190	< 0.6	< 1.3	< 1.0	< 0.9	< 2.0	< 0.1	< 2.0
BDE209	< 3.8	318	< 8.2	< 4.9	35	< 0.8	140

Bottlenose Dolphin *(Tursiops truncatus)* TTzH130 BDE concentration in ng per g lipid weight

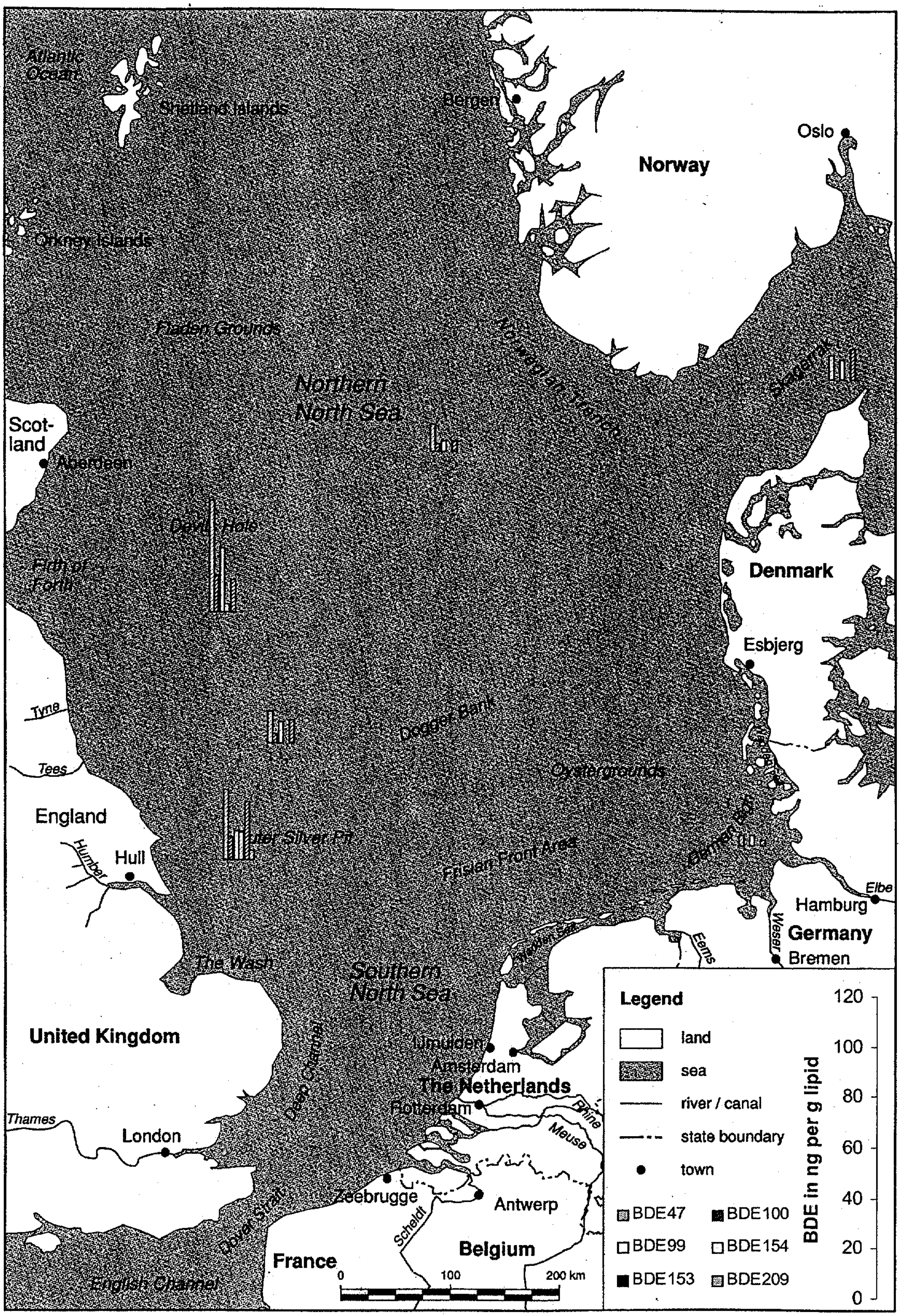
Organ:	Blubber	Liver	Kidney	Muscle
BDE28	68	48	56	58
BDE75	< 0.3	6.7	< 0.4	8.2
BDE71	< 0.3	< 0.8	< 0.4	< 1.0
BDE47	1300	1140	1340	1390
BDE66	41	37	41	48
BDE77	3.0	< 0.8	3.8	< 1.0
BDE100	240	260	330	330
BDE119	4.5	7.9	7.8	12
BDE99	500	590	770	720
BDE85	< 0.3	< 0.8	< 0.4	< 1.0
BDE154	31	74	90	95
BDE153	9.2	53	66	67
BDE138	1.9	< 0.8	4.9	< 1.0
BDE183	< 0.4	< 1.0	5.2	< 1.2
BDE190	< 0.4	< 1.0	< 0.5	< 1.3
BDE209	< 2.5	< 6.4	< 3.0	< 7.7

Annex 3 PBDEs in starfish, hermit crab and whelk





PBDEs in hermit crabs



PBDEs in whelks

Annex 4.1 PBDE concentrations in Tees food chain samples

µg/kg weight wet

No.	Species	Tissue	Latitude	Longitude	Location	%LIPID	BDE28	BDE75
01/1231/1	Crangon	Whole	54.615	-1.151667	North Gare	0.2	<0.2	0.01
01/1231/2	Crangon	Whole	54.615	-1.151667	North Gare	0.4	<0.2	<0.2
01/1232	Nereis sp	Whole	54.615	-1.151667	North Gare	0.4	0.03	0.03
01/1236/1	Asterias sp	Tentacle	54.653333	-1.163333	Seaton	2.2	0.2	<0.2
01/1236/2	Asterias sp	Whole	54.653333	-1.163333	Seaton	2.2	0.21	<0.2
01/1244/1	Sprats	Whole	54.653333	-1.163333	Dabholm	2	0.07	0.09
01/1244/2	Sprats	Whole	54.653333	-1.163333	Dabholm	1.6	0.06	0.1
01/1252/1	Whiting	Whole	54.653333	-1.163333	Dabholm	0.4	0.21	0.03
01/1252/2	Whiting	Muscle	54.653333	-1.163333	Dabholm	0.6	0.18	0.02
01/1259	Flounder	Liver	54.615	-1.151667	North Gare	7.5	0.01	<0.2
							BDE99	**BDE85**
01/1231/1	Crangon	Whole	54.615	-1.151667	North Gare		0.95	0.03
01/1231/2	Crangon	Whole	54.615	-1.151667	North Gare		0.9	<0.2
01/1232	Nereis sp	Whole	54.615	-1.151667	North Gare		6.9	<0.2
01/1236/1	Asterias sp	Tentacle	54.653333	-1.163333	Seaton		2.5	<0.2
01/1236/2	Asterias sp	Whole	54.653333	-1.163333	Seaton		2.4	<0.2
01/1244/1	Sprats	Whole	54.653333	-1.163333	Dabholm		2.2	<0.2
01/1244/2	Sprats	Whole	54.653333	-1.163333	Dabholm		2.2	<0.2
01/1252/1	Whiting	Whole	54.653333	-1.163333	Dabholm		3.5	<0.2
01/1252/2	Whiting	Muscle	54.653333	-1.163333	Dabholm		3.2	<0.2
01/1259	Flounder	Liver	54.615	-1.151667	North Gare		0.44	<0.2

BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
0.41	0.7	0.05	<0.2	0.24	0.07
0.39	0.65	0.05	<0.2	0.23	0.07
0.35	1.9	0.18	<0.2	1.1	<0.2
0.87	12	0.35	<0.2	2.7	<0.2
0.82	12	0.35	0.1	2.5	<0.2
2.2	4.5	0.18	0.02	1.7	0.05
2.3	4.8	0.21	0.05	1.8	0.2
1.2	7.1	0.5	0.03	2	0.07
1.1	6.9	0.48	0.02	1.9	0.07
0.13	1.7	0.06	<0.2	0.39	0.04

BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
0.17	0.2	<0.2	<0.2	<0.5	2.83
0.17	0.19	<0.2	<0.2	<0.5	2.65
1.43	1.1	<0.2	<0.2	<0.5	13.02
0.2	<0.2	<0.2	<0.2	<0.5	18.82
1	<0.2	<0.21	<0.2	<0.5	19.38
0.65	0.26	0.08	<0.2	<0.5	12
0.71	0.29	0.08	<0.2	<0.5	12.8
0.86	0.28	0.03	<0.2	<0.5	15.81
0.79	0.25	0.03	<0.2	<0.5	14.94
0.29	0.15	<0.2	<0.2	<0.5	3.21

Annex 4.2. PBDE concentrations in Tees food chain samples

µg/kg lipid ν

No.	Species	Tissue	Latitude	Longitude	Location	%LIPID	BDE28
01/1231/1	Crangon	Whole	54.615	-1.151667	North Gare	0.2	<100
01/1231/2	Crangon	Whole	54.615	-1.151667	North Gare	0.4	<50
01/1232	Nereis sp	Whole	54.615	-1.151667	North Gare	0.4	7.5
01/1236/1	Asterias sp	Tentacle	54.653333	-1.163333	Seaton	2.2	9.1
01/1236/2	Asterias sp	Whole	54.653333	-1.163333	Seaton	2.2	9.5
01/1244/1	Sprats	Whole	54.653333	-1.163333	Dabholm	2	3.5
01/1244/2	Sprats	Whole	54.653333	-1.163333	Dabholm	1.6	3.8
01/1252/1	Whiting	Whole	54.653333	-1.163333	Dabholm	0.4	52.5
01/1252/2	Whiting	Muscle	54.653333	-1.163333	Dabholm	0.6	30.0
01/1259	Flounder	Liver	54.615	-1.151667	North Gare	7.5	0.1
							BDE99
01/1231/1	Crangon	Whole	54.615	-1.151667	North Gare		475.0
01/1231/2	Crangon	Whole	54.615	-1.151667	North Gare		225.0
01/1232	Nereis sp	Whole	54.615	-1.151667	North Gare		1725.0
01/1236/1	Asterias sp	Tentacle	54.653333	-1.163333	Seaton		113.6
01/1236/2	Asterias sp	Whole	54.653333	-1.163333	Seaton		109.1
01/1244/1	Sprats	Whole	54.653333	-1.163333	Dabholm		110.0
01/1244/2	Sprats	Whole	54.653333	-1.163333	Dabholm		137.5
01/1252/1	Whiting	Whole	54.653333	-1.163333	Dabholm		875.0
01/1252/2	Whiting	Muscle	54.653333	-1.163333	Dabholm		533.3
01/1259	Flounder	Liver	54.615	-1.151667	North Gare		5.9

weight

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
5.0	205.0	350.0	25.0	<100	120.0	35.0
<50	97.5	162.5	12.5	<50	57.5	17.5
7.5	87.5	475.0	45.0	0.2	275.0	<50
<9	39.5	545.5	15.9	<9	122.7	<9
<9	37.3	545.5	15.9	4.5	113.6	<9
4.5	110.0	225.0	9.0	1.0	85.0	2.5
6.3	143.8	300.0	13.1	3.1	112.5	12.5
7.5	300.0	1775.0	125.0	7.5	500.0	17.5
3.3	183.3	1150.0	80.0	3.3	316.7	11.7
<2.7	1.7	22.7	0.8	<2.7	5.2	0.5

BDE85	BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
15.0	85.0	100.0	<100	<100	<100	1415.0
<100	42.5	47.5	<100	<100	<100	662.5
<50	357.5	275.0	<50	<50	<50	3255.2
<9	9.1	<9	<9	<9	<9	855.5
<9	45.5	<9	<9	<9	<9	880.9
<10	32.5	13.0	4.0	<10	<10	600.0
<10	44.4	18.1	5.0	<10	<10	800.0
<33	215.0	70.0	7.5	<33	<33	3952.5
<33	131.7	41.7	5.0	<33	<33	2490.0
<2.7	3.9	2.0	<2.7	<2.7	<2.7	42.8

Annex 4.3 PBDE concentrations in Tees food chain samples

PBDEs in porpoise blubber

µg/kg wet wei

No.	Latitude	Longitude	Location	Sex	Length	Age	%LIPID	BDE28
98/7469	55.015	-1.423333	Tyne/Tees	M	111	2	90	81
98/7470	52.608333	1.74	Great Yarmou	M	90	0	60	49
98/7483	54.591667	-0.466667	Durham	M	128	2	83	29
98/7484	54.505	-0.441667	North Whitby	M	143	4	90	<5
98/7489	55.038333	-1.431667	Whitley Bay	M	113	1	91	22
98/7493	54.278333	-0.386667	Scarborough	M	138	2	80	22
98/7499	52.5	1.76	Lowestoft	M	82	0	76	30
98/7501	52.883333	0.45	Wash	M	84	0	80	57
99/1293	54.083333	-0.183333	Bridlington Ba	M	117	0	90	26
99/1305	52.243333	1.631667	Sizewell	M	122	NA	91	<5

							BDE99	BDE85
98/7469	55.015	-1.423333	Tyne/Tees	M	111	2	<5	5
98/7470	52.608333	1.74	Great Yarmou	M	90	0	314	<5
98/7483	54.591667	-0.466667	Durham	M	128	2	721	<5
98/7484	54.505	-0.441667	North Whitby	M	143	4	643	<5
98/7489	55.038333	-1.431667	Whitley Bay	M	113	1	329	<5
98/7493	54.278333	-0.386667	Scarborough	M	138	2	531	<5
98/7499	52.5	1.76	Lowestoft	M	82	0	459	<5
98/7501	52.883333	0.45	Wash	M	84	0	326	<5
99/1293	54.083333	-0.183333	Bridlington Ba	M	117	0	339	<5
99/1305	52.243333	1.631667	Sizewell	M	122	NA	133	<5

ght

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
64	253	6109	78	9	<5	<5
31	157	2341	43	7	269	<5
<5	75	1245	48	14	324	<5
<5	64	1577	<5	<5	287	<5
27	42	1225	24	<5	236	<5
32	49	1332	24	<5	240	<5
49	89	2004	27	<5	413	<5
54	121	2317	40	10	375	<5
<5	<5	848	31	<5	124	<5
<5	<5	690	<5	<5	65	<5

BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<5	300	<5	<7.5	<7.5	6899
<5	28	<5	<7.5	<7.5	3239
<5	55	<5	<7.5	<7.5	2511
<5	116	<5	<7.5	<7.5	2687
<5	53	<5	<7.5	<7.5	1958
<5	55	<5	<7.5	<7.5	2285
<5	48	<5	<7.5	<7.5	3119
<5	42	14	<7.5	<7.5	3356
33	25	<5	<7.5	<7.5	1427
26	18	<5	<7.5	<7.5	932
				Mean	2841
				SD	1627
				Range	932 - 6899

Annex 4.4. PBDE concentrations in Tees food chain samples

PBDEs in porpoise blubber (males)

µg/kg lipid we

No.	Latitude	Longitude	Location	Sex	Length	Age	%LIPID	BDE28
98/7469	55.015	-1.423333	Tyne/Tees	M	111	2	90	90
98/7470	52.608333	1.74	Great Yarmou	M	90	0	60	82
98/7483	54.591667	-0.466667	Durham	M	128	2	83	35
98/7484	54.505	-0.441667	North Whitby	M	143	4	90	<6
98/7489	55.038333	-1.431667	Whitley Bay	M	113	1	91	24
98/7493	54.278333	-0.386667	Scarborough	M	138	2	80	28
98/7499	52.5	1.76	Lowestoft	M	82	0	76	39
98/7501	52.883333	0.45	Wash	M	84	0	80	71
99/1293	54.083333	-0.183333	Bridlington Ba	M	117	0	90	29
99/1305	52.243333	1.631667	Sizewell	M	122	NA	91	<6

No.	Latitude	Longitude	Location	Sex	Length	Age	BDE99	BDE85
98/7469	55.015	-1.423333	Tyne/Tees	M	111	2	<6	6
98/7470	52.608333	1.74	Great Yarmou	M	90	0	523	<6
98/7483	54.591667	-0.466667	Durham	M	128	2	869	<6
98/7484	54.505	-0.441667	North Whitby	M	143	4	714	<6
98/7489	55.038333	-1.431667	Whitley Bay	M	113	1	362	<6
98/7493	54.278333	-0.386667	Scarborough	M	138	2	664	<6
98/7499	52.5	1.76	Lowestoft	M	82	0	604	<6
98/7501	52.883333	0.45	Wash	M	84	0	408	<6
99/1293	54.083333	-0.183333	Bridlington Ba	M	117	0	377	<6
99/1305	52.243333	1.631667	Sizewell	M	122	NA	146	<6

ight

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
71	281	6788	87	10	<6	<6
52	262	3902	72	12	448	<6
<6	90	1500	58	17	390	<6
<6	71	1752	<6	<6	319	<6
30	46	1346	26	<6	259	<6
40	61	1665	30	<6	300	<6
64	117	2637	36	<6	543	<6
68	151	2896	50	13	469	<6
<6	<6	942	35	<6	138	<6
<6	<6	760	<6	<6	72	<6

BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<6	333	<6	<9	<9	7666
<6	47	<6	<9	<9	5398
<6	66	<6	<9	<9	3025
<6	129	<6	<9	<9	2986
<6	58	<6	<9	<9	2152
<6	69	<6	<9	<9	2856
<6	63	<6	<9	<9	4104
<6	53	18	<9	<9	4195
37	28	<6	<9	<9	1585
29	20	<6	<9	<9	1027

Annex 4.5. PBDE concentrations in Tees food chain samples

PBDEs in porpoise blubber (females)

µg/kg wet wei

No.	Latitude	Longitude	Location	Sex	Length	Age	%LIPID	BDE28
98/7466	54.32	-0.4	Scarborough	F	110	0	88	53
98/7467	54.53	0.05	Tyne/Tees	F	123	1	84	42
98/7468	54.53	0.05	Tyne/Tees	F	129	0	95	39
98/7477	52.936667	0.485	Wash	F	84	0	77	71
98/7479	53.993333	-0.061667	Hornsea	F	126	1	90	30
98/7485	54.658333	-0.458333	Durham	F	132	5	88	23
98/7488	52.66667	1.736667	Great Yarmou	F	147	4	90	29
98/7490	55.038333	-1.431667	Whitley Bay	F	145	5	93	22
98/7491	53.341667	0.268333	Mablethorpe	F	100	0	82	38
98/7500	52.788333	1.605	Sea Palling	F	154	NA	84	40
99/1289	52.951667	1.215	Sheringham	F	124	2	87	64
99/1292	55.038333	-1.431667	Whitley Bay	F	156	4	86	12
99/1294	52.953333	1.81667	Sheringham	F	164	9	85	10
99/1298	55.256667	-1.556667	Newbiggin	F	148	NA	90	<5
99/1299	54.083333	-0.183333	Bridlington Ba	F	101	0	76	<5
99/1302	52.2	1.616667	Sizewell	F	115	0	89	<5
99/1303	53.706667	-0.515	R. Humber	F	98	0	76	<5
99/1304	53.37	0.253333	Mablethorpe	F	118	NA	90	<5

							BDE99	BDE85
98/7466	54.32	-0.4	Scarborough	F	110	0	281	<5
98/7467	54.53	0.05	Tyne/Tees	F	123	1	855	<5
98/7468	54.53	0.05	Tyne/Tees	F	129	0	<5	<5
98/7477	52.936667	0.485	Wash	F	84	0	774	<5
98/7479	53.993333	-0.061667	Hornsea	F	126	1	757	<5
98/7485	54.658333	-0.458333	Durham	F	132	5	533	<5
98/7488	52.66667	1.736667	Great Yarmou	F	147	4	386	<5
98/7490	55.038333	-1.431667	Whitley Bay	F	145	5	153	<5
98/7491	53.341667	0.268333	Mablethorpe	F	100	0	1156	<5
98/7500	52.788333	1.605	Sea Palling	F	154	NA	1116	<5
99/1289	52.951667	1.215	Sheringham	F	124	2	1287	<5
99/1292	55.038333	-1.431667	Whitley Bay	F	156	4	264	<5
99/1294	52.953333	1.81667	Sheringham	F	164	9	190	<5
99/1298	55.256667	-1.556667	Newbiggin	F	148	NA	104	<5
99/1299	54.083333	-0.183333	Bridlington Ba	F	101	0	903	<5
99/1302	52.2	1.616667	Sizewell	F	115	0	93	<5
99/1303	53.706667	-0.515	R. Humber	F	98	0	81	<5
99/1304	53.37	0.253333	Mablethorpe	F	118	NA	259	<5

ght

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
27	128	2080	53	8	296	<5
28	88	1839	34	2	315	<5
38	83	2375	35	3	456	<5
<5	220	4106	70	<5	486	<5
42	74	2308	36	<5	575	<5
31	54	1383	29	<5	293	<5
<5	70	1459	30	<5	197	<5
<5	63	466	24	<5	67	<5
43	55	2862	45	<5	634	<5
56	115	2498	46	6	541	<5
5	<5	2526	70	9	633	<5
<5	<5	378	22	<5	68	<5
<5	<5	402	13	<5	67	<5
<5	<5	187	<5	<5	40	<5
<5	<5	2534	<5	<5	559	<5
<5	<5	540	<5	<5	63	<5
<5	<5	336	<5	<5	28	<5
<5	<5	1281	<5	<5	36	<5

BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<5	49	6	<7.5	<7.5	2981
<5	66	5	<7.5	<7.5	3274
<5	87	7	<7.5	<7.5	3123
<5	47	<5	<7.5	<7.5	5774
<5	97	<5	<7.5	<7.5	3919
<5	78	<5	<7.5	<7.5	2424
<5	47	<5	<7.5	<7.5	2218
<5	34	21	<7.5	<7.5	850
<5	59	<5	<7.5	<7.5	4892
<5	283	<5	<7.5	<7.5	4701
168	103	<5	<7.5	<7.5	4865
46	36	<5	<7.5	<7.5	827
31	23	<5	<7.5	<7.5	736
24	15	<5	<7.5	<7.5	370
101	42	<5	<7.5	<7.5	4140
23	11	<5	<7.5	<7.5	729
10	6	<5	<7.5	<7.5	461
14	13	<5	<7.5	<7.5	1603
				Mean	2660
				SD	1777
				Range	370 - 5774

Annex 4.6. PBDE concentrations in Tees food chain samples

PBDEs in porpoise blubber (females)

µg/kg lipid we

No.	Latitude	Longitude	Location	Sex	Length	Age	%LIPID	BDE28
98/7466	54.32	-0.4	Scarborough	F	110	0	88	60
98/7467	54.53	0.05	Tyne/Tees	F	123	1	84	50
98/7468	54.53	0.05	Tyne/Tees	F	129	0	95	41
98/7477	52.936667	0.485	Wash	F	84	0	77	92
98/7479	53.993333	-0.061667	Hornsea	F	126	1	90	33
98/7485	54.658333	-0.458333	Durham	F	132	5	88	26
98/7488	52.66667	1.736667	Great Yarmou	F	147	4	90	32
98/7490	55.038333	-1.431667	Whitley Bay	F	145	5	93	24
98/7491	53.341667	0.268333	Mablethorpe	F	100	0	82	46
98/7500	52.788333	1.605	Sea Palling	F	154	NA	84	48
99/1289	52.951667	1.215	Sheringham	F	124	2	87	73
99/1292	55.038333	-1.431667	Whitley Bay	F	156	4	86	14
99/1294	52.953333	1.81667	Sheringham	F	164	9	85	12
99/1298	55.256667	-1.556667	Newbiggin	F	148	NA	90	<5.8
99/1299	54.083333	-0.183333	Bridlington Ba	F	101	0	76	<5.8
99/1302	52.2	1.616667	Sizewell	F	115	0	89	<5.8
99/1303	53.706667	-0.515	R. Humber	F	98	0	76	<5.8
99/1304	53.37	0.253333	Mablethorpe	F	118	NA	90	<5.8

No.	Latitude	Longitude	Location	Sex	Length	Age	BDE99	BDE85
98/7466	54.32	-0.4	Scarborough	F	110	0	319	<5.8
98/7467	54.53	0.05	Tyne/Tees	F	123	1	1018	<5.8
98/7468	54.53	0.05	Tyne/Tees	F	129	0	#VALUE!	<5.8
98/7477	52.936667	0.485	Wash	F	84	0	1005	<5.8
98/7479	53.993333	-0.061667	Hornsea	F	126	1	841	<5.8
98/7485	54.658333	-0.458333	Durham	F	132	5	606	<5.8
98/7488	52.66667	1.736667	Great Yarmou	F	147	4	429	<5.8
98/7490	55.038333	-1.431667	Whitley Bay	F	145	5	165	<5.8
98/7491	53.341667	0.268333	Mablethorpe	F	100	0	1410	<5.8
98/7500	52.788333	1.605	Sea Palling	F	154	NA	1329	<5.8
99/1289	52.951667	1.215	Sheringham	F	124	2	1480	<5.8
99/1292	55.038333	-1.431667	Whitley Bay	F	156	4	307	<5.8
99/1294	52.953333	1.81667	Sheringham	F	164	9	223	<5.8
99/1298	55.256667	-1.556667	Newbiggin	F	148	NA	116	<5.8
99/1299	54.083333	-0.183333	Bridlington Ba	F	101	0	1195	<5.8
99/1302	52.2	1.616667	Sizewell	F	115	0	104	<5.8
99/1303	53.706667	-0.515	R. Humber	F	98	0	107	<5.8
99/1304	53.37	0.253333	Mablethorpe	F	118	NA	289	<5.8

ight

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
31	145	2364	60	9	336	<5.8
33	105	2189	40	2	375	<5.8
40	87	2500	37	3	480	<5.8
<5.8	286	5332	91	<5.8	631	<5.8
47	82	2564	40	<5.8	639	<5.8
35	61	1572	33	<5.8	333	<5.8
<5.8	78	1621	33	<5.8	219	<5.8
<5.8	68	501	26	<5.8	72	<5.8
52	67	3490	55	<5.8	773	<5.8
67	137	2974	55	7	644	<5.8
5	<5.8	2903	81	11	727	<5.8
<5.8	<5.8	440	26	<5.8	80	<5.8
<5.8	<5.8	472	15	<5.8	79	<5.8
<5.8	<5.8	209	<5.8	<5.8	45	<5.8
<5.8	<5.8	3352	<5.8	<5.8	740	<5.8
<5.8	<5.8	605	<5.8	<5.8	70	<5.8
<5.8	<5.8	444	<5.8	<5.8	38	<5.8
<5.8	<5.8	1430	<5.8	<5.8	40	<5.8

BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<5.8	56	7	<8.7	<8.7	3388
<5.8	79	6	<8.7	<8.7	3898
<5.8	92	7	<8.7	<8.7	#VALUE!
<5.8	61	<5.8	<8.7	<8.7	7499
<5.8	108	<5.8	<8.7	<8.7	4354
<5.8	89	<5.8	<8.7	<8.7	2755
<5.8	52	<5.8	<8.7	<8.7	2464
<5.8	37	23	<8.7	<8.7	914
<5.8	72	<5.8	<8.7	<8.7	5966
<5.8	337	<5.8	<8.7	<8.7	5596
193	119	<5.8	<8.7	<8.7	5591
53	42	<5.8	<8.7	<8.7	961
37	27	<5.8	<8.7	<8.7	866
27	16	<5.8	<8.7	<8.7	413
133	55	<5.8	<8.7	<8.7	5476
25	13	<5.8	<8.7	<8.7	817
13	7	<5.8	<8.7	<8.7	610
15	15	<5.8	<8.7	<8.7	1789

Annex 4.7. PBDE concentrations in Tees food chain samples

PBDEs in whiting (muscle tissue)

µg/kg wet wei

No.	Species	Tissue	Latitude	Longitude	Location	%LIPID	BDE28
01/1095	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	0.11
01/1104	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	0.11
01/1113	Whiting	Muscle	54.65	-1.167	Off Tees	0.6	0.14
01/1120	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	0.12
01/1127	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	0.06
01/1134	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	0.08
01/1141	Whiting	Muscle	54.65	-1.167	Off Tees	0.2	0.02
01/1147	Whiting	Muscle	54.65	-1.167	Off Tees	0.2	0.03
01/1155	Whiting	Muscle	54.65	-1.167	Off Tees	0.2	0.02
01/1162	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	0.09
							BDE99
01/1095	Whiting	Muscle	54.65	-1.167	Off Tees		1.7
01/1104	Whiting	Muscle	54.65	-1.167	Off Tees		1.8
01/1113	Whiting	Muscle	54.65	-1.167	Off Tees		2
01/1120	Whiting	Muscle	54.65	-1.167	Off Tees		1.5
01/1127	Whiting	Muscle	54.65	-1.167	Off Tees		1.4
01/1134	Whiting	Muscle	54.65	-1.167	Off Tees		1.4
01/1141	Whiting	Muscle	54.65	-1.167	Off Tees		0.12
01/1147	Whiting	Muscle	54.65	-1.167	Off Tees		0.36
01/1155	Whiting	Muscle	54.65	-1.167	Off Tees		0.14
01/1162	Whiting	Muscle	54.65	-1.167	Off Tees		0.32

ght

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
0.01	0.54	2.6	0.25	<0.2	0.59	0.1
0.01	0.04	3	0.23	<0.2	0.59	0.04
0.29	0.63	3	0.25	<0.2	0.56	0.05
0.01	0.02	2.6	0.19	<0.2	0.45	0.05
<0.2	0.02	1.8	0.16	<0.2	0.37	0.07
0.01	0.03	1.8	0.16	<0.2	0.37	0.04
<0.2	0.17	1.1	0.05	<0.2	0.25	0.05
<0.2	0.22	1.3	0.08	<0.2	0.26	0.05
<0.2	0.28	1.2	0.05	<0.2	0.32	0.05
<0.2	0.49	2.1	0.13	<0.2	0.45	0.07

BDE85	BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<0.2	0.28	0.13	<0.2	<0.2	<0.5	6.31
<0.2	0.26	0.14	<0.2	<0.2	<0.5	6.22
<0.2	0.22	0.14	<0.2	<0.2	<0.5	7.28
<0.2	0.16	0.11	<0.2	<0.2	<0.5	5.21
<0.2	0.16	0.1	<0.2	<0.2	<0.5	4.14
<0.2	0.14	0.1	<0.2	<0.2	<0.5	4.13
<0.2	0.07	0.03	<0.2	<0.2	<0.5	1.86
<0.2	0.07	0.03	<0.2	<0.2	<0.5	2.4
<0.2	0.08	<0.2	<0.2	<0.2	<0.5	2.14
<0.2	0.17	0.04	<0.2	<0.2	<0.5	3.86
					Mean	4.36
					SD	1.88
					Range	2.4 - 7.28

Annex 4.8. PBDE concentrations in Tees food chain samples

PBDEs in whiting (muscle tissue)

µg/kg lipid w

No.	Species	Tissue	Latitude	Longitude	Location	%LIPID	BDE28
01/1095	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	28
01/1104	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	28
01/1113	Whiting	Muscle	54.65	-1.167	Off Tees	0.6	23
01/1120	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	30
01/1127	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	15
01/1134	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	20
01/1141	Whiting	Muscle	54.65	-1.167	Off Tees	0.2	10
01/1147	Whiting	Muscle	54.65	-1.167	Off Tees	0.2	15
01/1155	Whiting	Muscle	54.65	-1.167	Off Tees	0.2	10
01/1162	Whiting	Muscle	54.65	-1.167	Off Tees	0.4	23
							BDE99
01/1095	Whiting	Muscle	54.65	-1.167	Off Tees		425
01/1104	Whiting	Muscle	54.65	-1.167	Off Tees		450
01/1113	Whiting	Muscle	54.65	-1.167	Off Tees		333
01/1120	Whiting	Muscle	54.65	-1.167	Off Tees		375
01/1127	Whiting	Muscle	54.65	-1.167	Off Tees		350
01/1134	Whiting	Muscle	54.65	-1.167	Off Tees		350
01/1141	Whiting	Muscle	54.65	-1.167	Off Tees		60
01/1147	Whiting	Muscle	54.65	-1.167	Off Tees		180
01/1155	Whiting	Muscle	54.65	-1.167	Off Tees		70
01/1162	Whiting	Muscle	54.65	-1.167	Off Tees		80

'eight

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
3	135	650	63	<50	148	25
3	10	750	58	<50	148	10
48	105	500	42	<50	93	8
3	5	650	48	<50	113	13
<50	5	450	40	<50	93	18
3	8	450	40	<50	93	10
<50	85	550	25	<50	125	25
<50	110	650	40	<50	130	25
<50	140	600	25	<50	160	25
<50	123	525	33	<50	113	18

BDE85	BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<50	70	33	<50	<50	<100	1578
<50	65	35	<50	<50	<100	1555
<50	37	23	<50	<50	<100	1213
<50	40	28	<50	<50	<100	1303
<50	40	25	<50	<50	<100	1035
<50	35	25	<50	<50	<100	1033
<50	35	15	<50	<50	<100	930
<50	35	15	<50	<50	<100	1200
<50	40	<50	<50	<50	<100	1070
<50	43	10	<50	<50	<100	965

Annex 4.9. PBDE concentrations in Tees food chain samples

PBDEs in whiting from off Tees (liver)

μg/kg wet wei

No.	Species	Tissue	Latitude	Longitude	Location	%LIPID	BDE28
01/1096	Whiting	Liver	54.65	-1.167	Off Tees	34.4	13.95
01/1105	Whiting	Liver	54.65	-1.167	Off Tees	36.2	11.2
01/1114	Whiting	Liver	54.65	-1.167	Off Tees	41.6	16.1
01/1121	Whiting	Liver	54.65	-1.167	Off Tees	37.4	16.6
01/1128	Whiting	Liver	54.65	-1.167	Off Tees	39.7	13
01/1135	Whiting	Liver	54.65	-1.167	Off Tees	43.4	22.5
01/1142	Whiting	Liver	54.65	-1.167	Off Tees	22.5	2.8
01/1148	Whiting	Liver	54.65	-1.167	Off Tees	22.4	11.9
01/1156	Whiting	Liver	54.65	-1.167	Off Tees	21.5	3.1
01/1163	Whiting	Liver	54.65	-1.167	Off Tees	19.2	6.6

No.	Species	Tissue	Latitude	Longitude	Location		BDE99
01/1096	Whiting	Liver	54.65	-1.167	Off Tees		290
01/1105	Whiting	Liver	54.65	-1.167	Off Tees		14
01/1114	Whiting	Liver	54.65	-1.167	Off Tees		<
01/1121	Whiting	Liver	54.65	-1.167	Off Tees		18.6
01/1128	Whiting	Liver	54.65	-1.167	Off Tees		<
01/1135	Whiting	Liver	54.65	-1.167	Off Tees		<
01/1142	Whiting	Liver	54.65	-1.167	Off Tees		<
01/1148	Whiting	Liver	54.65	-1.167	Off Tees		<
01/1156	Whiting	Liver	54.65	-1.167	Off Tees		<
01/1163	Whiting	Liver	54.65	-1.167	Off Tees		75.6

ght

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
<0.2	<0.2	361	30.11	<0.2	89.1	<0.2
<0.2	<0.2	337	31.7	<0.2	84.1	7.54
<0.2	<0.2	384	34	<0.2	82.4	<0.2
<0.2	<0.2	415	31.6	<0.2	80.2	9.7
<0.2	<0.2	371	31.3	<0.2	85.3	<0.2
<0.2	<0.2	449	39.5	<0.2	99.6	<0.2
<0.2	<0.2	144	5.8	<0.2	36.6	<0.2
<0.2	<0.2	336	18.7	<0.2	70.3	4.81
<0.2	<0.2	124	5.1	<0.2	37.9	<0.2
<0.2	<0.2	239	14.2	<0.2	64.8	<0.2

BDE85	BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<0.2	52.8	24.7	<0.2	<0.2	<0.5	862
<0.2	48.7	31.1	<0.2	<0.2	<0.5	565
<0.2	43.18	28.4	<0.2	<0.2	<0.5	588
<0.2	32.7	27.4	<0.2	<0.2	<0.5	632
<0.2	45.6	28.7	<0.2	<0.2	<0.5	575
<0.2	46.1	36.2	<0.2	<0.2	<0.5	693
<0.2	15.3	3.9	<0.2	<0.2	<0.5	208
<0.2	23.1	10.5	<0.2	<0.2	<0.5	475
<0.2	13.4	3.4	<0.2	<0.2	<0.5	187
<0.2	40.5	9.6	<0.2	<0.2	<0.5	450
					Mean	524
					SD	206
					Range	187 - 862

Annex 4.10. PBDE concentrations in Tees food chain samples

PBDEs in whiting from off Tees (liver)

µg/kg lipid we

No.	Species	Tissue	Latitude	Longitude	Location	%LIPID	BDE28
01/1096	Whiting	Liver	54.65	-1.167	Off Tees	34.4	41
01/1105	Whiting	Liver	54.65	-1.167	Off Tees	36.2	31
01/1114	Whiting	Liver	54.65	-1.167	Off Tees	41.6	39
01/1121	Whiting	Liver	54.65	-1.167	Off Tees	37.4	44
01/1128	Whiting	Liver	54.65	-1.167	Off Tees	39.7	33
01/1135	Whiting	Liver	54.65	-1.167	Off Tees	43.4	52
01/1142	Whiting	Liver	54.65	-1.167	Off Tees	22.5	12
01/1148	Whiting	Liver	54.65	-1.167	Off Tees	22.4	53
01/1156	Whiting	Liver	54.65	-1.167	Off Tees	21.5	14
01/1163	Whiting	Liver	54.65	-1.167	Off Tees	19.2	34

						BDE99
01/1096	Whiting	Liver	54.65	-1.167	Off Tees	843
01/1105	Whiting	Liver	54.65	-1.167	Off Tees	39
01/1114	Whiting	Liver	54.65	-1.167	Off Tees	<0.625
01/1121	Whiting	Liver	54.65	-1.167	Off Tees	50
01/1128	Whiting	Liver	54.65	-1.167	Off Tees	<0.625
01/1135	Whiting	Liver	54.65	-1.167	Off Tees	<0.625
01/1142	Whiting	Liver	54.65	-1.167	Off Tees	<0.625
01/1148	Whiting	Liver	54.65	-1.167	Off Tees	<0.625
01/1156	Whiting	Liver	54.65	-1.167	Off Tees	<0.625
01/1163	Whiting	Liver	54.65	-1.167	Off Tees	394

ight

BDE75	BDE71	BDE47	BDE66	BDE77	BDE100	BDE119
<0.625	<0.625	1049	88	<0.625	259	<0.625
<0.625	<0.625	931	88	<0.625	232	21
<0.625	<0.625	923	82	<0.625	198	<0.625
<0.625	<0.625	1110	84	<0.625	214	26
<0.625	<0.625	935	79	<0.625	215	<0.625
<0.625	<0.625	1035	91	<0.625	229	<0.625
<0.625	<0.625	640	26	<0.625	163	<0.625
<0.625	<0.625	1500	83	<0.625	314	21
<0.625	<0.625	577	24	<0.625	176	<0.625
<0.625	<0.625	1245	74	<0.625	338	<0.625

BDE85	BDE154	BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
<0.625	153	72	<0.625	<0.625	<1.56	1437
<0.625	135	86	<0.625	<0.625	<1.56	1303
<0.625	104	68	<0.625	<0.625	<1.56	1242
<0.625	87	73	<0.625	<0.625	<1.56	1479
<0.625	115	72	<0.625	<0.625	<1.56	1261
<0.625	106	83	<0.625	<0.625	<1.56	1407
<0.625	68	17	<0.625	<0.625	<1.56	841
<0.625	103	47	<0.625	<0.625	<1.56	1972
<0.625	62	16	<0.625	<0.625	<1.56	791
<0.625	211	50	<0.625	<0.625	<1.56	1691

Annex 4.11. PBDE concentrations in Tees food chain samples

PBDEs in cormorant livers

µg/kg wet weight

No.	%LIPID	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77	BDE100
99/2600	1.6	<0.2	<0.2	<0.2	5.1	<0.2	<0.2	3.7
99/2601	<1	<0.2	<0.2	<0.2	4.3	<0.2	<0.2	2.3
99/2602	<1	<0.2	<0.2	<0.2	2.4	<0.2	<0.2	0.5
99/2610	1.2	<0.2	<0.2	<0.2	4.8	<0.2	<0.2	2.0
99/2612	1.2	<0.2	<0.2	<0.2	7.3	<0.2	<0.2	3.2
99/2613	<1	<0.2	<0.2	<0.2	15.5	<0.2	<0.2	3.9
99/2614	1.6	<0.2	<0.2	<0.2	14.1	<0.2	<0.2	9.1
99/2615	2	0.4	<0.2	<0.2	69.3	<0.2	<0.2	30.0
99/2616	<1	<0.2	<0.2	<0.2	5.1	<0.2	<0.2	2.5
99/2617	1.2	<0.2	<0.2	<0.2	2.3	<0.2	<0.2	1.4
99/2618	2	<0.2	<0.2	<0.2	66	<0.2	<0.2	26
99/2619	2	<0.2	<0.2	<0.2	17	<0.2	<0.2	20
99/2620	1.2	<0.2	<0.2	<0.2	13	<0.2	<0.2	6
99/2621	1.2	<0.2	<0.2	<0.2	5	<0.2	<0.2	1.4
99/2622	<1	<0.2	<0.2	<0.2	1.8	<0.2	<0.2	0.7
99/2623	<1	<0.2	<0.2	<0.2	1.7	<0.2	<0.2	0.6
99/2624	<1	<0.2	<0.2	<0.2	4.3	<0.2	<0.2	1.6
99/2625	2.4	<0.2	<0.2	<0.2	4.2	<0.2	<0.2	1.5
99/2626	<1	<0.2	<0.2	<0.2	17	<0.2	<0.2	12
99/2627	1.6	<0.2	<0.2	<0.2	9	<0.2	<0.2	4.5

	BDE99	BDE85	BDE154	BDE153	BDE138	BDE190	BDE209
99/2600	1.3	<0.2	2	1.44	<5	<1	<0.5
99/2601	3.9	<0.2	1.12	1.04	<5	<1	<0.5
99/2602	0.6	<0.2	0.34	<0.2	<5	<1	<0.5
99/2610	2.0	<0.2	1	0.72	<5	<1	<0.5
99/2612	2.1	<0.2	1.31	1.13	<5	<1	<0.5
99/2613	2.3	<0.2	2.04	1.45	<5	<1	<0.5
99/2614	3.4	<0.2	8	5	<5	<1	<0.5
99/2615	5.1	<0.2	9	14	<5	<1	<0.5
99/2616	1.9	<0.2	1.74	1.48	<5	<1	<0.5
99/2617	0.8	<0.2	0.49	0.61	<5	<1	<0.5
99/2618	15	<0.2	3.9	5	<0.2	<1	<0.5
99/2619	6	<0.2	5.0	12	<0.2	<1	<0.5
99/2620	8	<0.2	1.5	1.4	<0.2	<1	<0.5
99/2621	0.9	<0.2	0.7	0.5	<0.2	<1	<0.5
99/2622	0.5	<0.2	<0.2	0.2	<0.2	<1	<0.5
99/2623	0.5	<0.2	<0.2	0.2	<0.2	<1	<0.5
99/2624	2.6	<0.2	0.3	0.4	<0.2	<1	<0.5
99/2625	1.7	<0.2	0.5	0.5	<0.2	<1	<0.5
99/2626	9	<0.2	3.6	1.9	<0.2	<1	<0.5
99/2627	5	<0.2	0.9	1.6	<0.2	<1	<0.5

BDE119
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
0.6
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2

Sum BDE (ex 209)
13.5
12.7
3.7
10.5
15.0
25.1
41.1
127.5
12.7
5.5
115.3
59.8
30.3
8.4
3.2
3.0
9.2
8.4
43.6
20.4

Annex 4.12. PBDE concentrations in Tees food chain samples

PBDEs in cormorant livers

µg/kg wet weight

No.	%LIPID	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77	BDE100
00/2248	2	<0.2	<0.2	<0.2	2.1	<0.2	<0.2	2.4
00/2250	2	<0.2	<0.2	<0.2	8.6	<0.2	<0.2	6.3
00/2251	4	<0.2	<0.2	<0.2	14.2	<0.2	<0.2	2.1
00/2252	2.4	<0.2	<0.2	<0.2	5.6	<0.2	<0.2	2.8
00/2253	2.4	<0.2	<0.2	<0.2	5.8	<0.2	<0.2	6.5
00/2254	1.2	<0.2	<0.2	<0.2	3.6	<0.2	<0.2	1.4
00/2255	2.8	<0.2	<0.2	<0.2	3.4	<0.2	<0.2	1.2
00/2257	1.6	<0.2	<0.2	<0.2	3.6	<0.2	<0.2	1.6
00/2258	3.2	<0.2	<0.2	<0.2	76.1	<0.2	<0.2	38.2
00/2259	1.6	<0.2	<0.2	<0.2	6.9	<0.2	<0.2	1.1
00/2256	4	<0.2	<0.2	<0.2	12.1	<0.2	<0.2	3.4
00/2260	0.8	<0.2	<0.2	<0.2	39.0	<0.2	<0.2	12.2
00/2261	0.8	<0.2	<0.2	<0.2	8.1	<0.2	<0.2	3.9
00/2262	2.4	<0.2	<0.2	<0.2	5.2	<0.2	<0.2	4.5
00/2263	1.6	<0.2	<0.2	<0.2	9.7	<0.2	<0.2	5.4
00/2264	1.6	<0.2	<0.2	<0.2	5.2	<0.2	<0.2	4.8
00/2265	1.6	<0.2	<0.2	<0.2	1.1	<0.2	<0.2	0.6
00/2266	3.6	<0.2	<0.2	<0.2	10.2	<0.2	<0.2	0.9
00/2267	1.2	<0.2	<0.2	<0.2	1.8	<0.2	<0.2	<0.2
00/2268	1.6	<0.2	<0.2	<0.2	10.0	<0.2	<0.2	13.5

	BDE99	BDE85	BDE154	BDE153	BDE138	BDE190	BDE209
00/2248	0.9	<0.2	0.7	0.6	<0.2	<1	<0.5
00/2250	8.0	<0.2	1.5	1.5	<0.2	<1	<0.5
00/2251	0.8	<0.2	0.8	0.3	<0.2	<1	<0.5
00/2252	1.9	<0.2	0.4	0.6	<0.2	<1	<0.5
00/2253	3.7	<0.2	2.2	5.5	<0.2	<1	<0.5
00/2254	2.1	<0.2	0.4	0.5	<0.2	<1	<0.5
00/2255	1.0	<0.2	0.3	0.3	<0.2	<1	<0.5
00/2257	1.2	<0.2	0.2	0.3	<0.2	<1	<0.5
00/2258	11.6	<0.2	9.4	5.2	<0.2	<1	<0.5
00/2259	0.8	<0.2	0.3	0.2	<0.2	<1	<0.5
00/2256	2.5	<0.2	1.2	1.2	<0.2	<1	<0.5
00/2260	1.8	<0.2	4.6	2.2	<0.2	<1	<0.5
00/2261	0.5	<0.2	<0.2	1.5	<0.2	<1	<0.5
00/2262	1.7	<0.2	1.9	0.8	<0.2	<1	<0.5
00/2263	7.2	<0.2	1.3	1.7	<0.2	<1	<0.5
00/2264	2.1	<0.2	1.3	1.2	<0.2	<1	<0.5
00/2265	<0.2	<0.2	0.3	<0.2	<0.2	<1	<0.5
00/2266	2.5	<0.2	0.3	0.3	<0.2	<1	<0.5
00/2267	<0.2	<0.2	<0.2	<0.2	<0.2	<1	<0.5
00/2268	2.1	<0.2	4.4	1.8	<0.2	<1	<0.5

BDE119

<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
<0.2
0.4
<0.2
<0.2
<0.2
0.4
<0.2
<0.2
<0.2
0.3

Sum BDE (ex 209)

6.8
25.8
18.2
11.3
23.6
7.9
6.2
6.9
140.4
9.4
20.3
60.1
14.0
14.0
25.2
14.9
2.0
14.2
1.8
32.1

Annex 4.13. PBDE concentrations in Tees food chain samples

PBDEs in cormorant livers

µg/kg wet weight

No.	%LIPID	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77	BDE100
00/2269	2.8	<0.2	<0.2	<0.2	1.1	<0.2	<0.2	0.8
00/2270	2.4	<0.2	<0.2	<0.2	3.6	<0.2	<0.2	3.2
00/2271	1.6	<0.2	0.7	<0.2	28.5	<0.2	<0.2	30.1
00/2272	1.6	<0.2	<0.2	<0.2	4.5	<0.2	<0.2	1.6
00/2273	4.4	<0.2	<0.2	<0.2	2.6	<0.2	<0.2	0.6
00/2274	1.6	<0.2	<0.2	<0.2	20.7	<0.2	<0.2	6.6
00/2275	2	<0.2	<0.2	<0.2	2.8	<0.2	<0.2	1.7

		BDE99	BDE85	BDE154	BDE153	BDE138	BDE190	BDE209
00/2269		<0.2	<0.2	0.2	0.2	<0.2	<0.2	<0.5
00/2270		3.4	<0.2	1.0	0.8	<0.2	<0.2	<0.5
00/2271		5.6	<0.2	7.5	2.4	<0.2	<0.2	<0.5
00/2272		1.7	<0.2	0.5	0.5	<0.2	<0.2	<0.5
00/2273		0.8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5
00/2274		2.8	<0.2	1.5	1.1	<0.2	<0.2	<0.5
00/2275		1.1	<0.2	0.5	0.4	<0.2	<0.2	<0.5

BDE119

<0.2
<0.2
1.1
<0.2
<0.2
<0.2
<0.2

Sum BDE (ex 209)

2.4
12.0
75.8
8.9
3.9
32.6
6.5

Annex 4.14. PBDE concentrations in Tees food chain samples

PBDEs in cormorant livers

			µg/kg lipid weight					
No.	**%LIPID**	**BDE28**	**BDE75**	**BDE71**	**BDE47**	**BDE66**	**BDE77**	**BDE100**
99/2600	1.6	<12.5	<12.5	<12.5	317	<12.5	<12.5	229
99/2601	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2602	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2610	1.2	<12.5	<12.5	<12.5	400	<12.5	<12.5	168
99/2612	1.2	<12.5	<12.5	<12.5	605	<12.5	<12.5	267
99/2613	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2614	1.6	<12.5	<12.5	<12.5	880	<12.5	<12.5	569
99/2615	2	18	<12.5	<12.5	3465	<12.5	<12.5	1500
99/2616	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2617	1.2	<12.5	<12.5	<12.5	188	<12.5	<12.5	113
99/2618	2	<12.5	<12.5	<12.5	3308	<12.5	<12.5	1284
99/2619	2	<12.5	<12.5	<12.5	871	<12.5	<12.5	981
99/2620	1.2	<12.5	<12.5	<12.5	1084	<12.5	<12.5	540
99/2621	1.2	<12.5	<12.5	<12.5	415	<12.5	<12.5	113
99/2622	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2623	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2624	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2625	2.4	<12.5	<12.5	<12.5	174	<12.5	<12.5	63
99/2626	<1	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5
99/2627	1.6	<12.5	<12.5	<12.5	558	<12.5	<12.5	279
	1.6							

	BDE99	**BDE85**	**BDE154**	**BDE153**	**BDE138**	**BDE190**	**BDE209**
99/2600	83	<12.5	125	90	<12.5	<12.5	<25
99/2601	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2602	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2610	166	<12.5	83	60	<12.5	<12.5	<25
99/2612	175	<12.5	109	94	<12.5	<12.5	<25
99/2613	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2614	212	<12.5	529	336	<12.5	<12.5	<25
99/2615	255	<12.5	450	689	<12.5	<12.5	<25
99/2616	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2617	68	<12.5	41	51	<12.5	<12.5	<25
99/2618	729	<12.5	196	247	<12.5	<12.5	<25
99/2619	299	<12.5	252	589	<12.5	<12.5	<25
99/2620	663	<12.5	123	118	<12.5	<12.5	<25
99/2621	72	<12.5	58	44	<12.5	<12.5	<25
99/2622	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2623	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2624	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2625	72	<12.5	20	20	<12.5	<12.5	<25
99/2626	<12.5	<12.5	<12.5	<12.5	<12.5	<12.5	<25
99/2627	282	<12.5	58	99	<12.5	<12.5	<25

BDE119

<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
40
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5
<12.5

Sum BDE (ex 209)

843
0
0
877
1250
0
2566
6376
0
462
5763
2991
2527
701
0
0
0
349
0
1276

Annex 4.15. PBDE concentrations in Tees food chain samples

PBDEs in cormorant livers

		µg/kg lipid weight						
No.	**%LIPID**	**BDE28**	**BDE75**	**BDE71**	**BDE47**	**BDE66**	**BDE77**	**BDE100**
00/2248	2	<9.4	<9.4	<9.4	107	<9.4	<9.4	121
00/2250	2	<9.4	<9.4	<9.4	431	<9.4	<9.4	314
00/2251	4	<9.4	<9.4	<9.4	354	<9.4	<9.4	53
00/2252	2.4	<9.4	<9.4	<9.4	233	<9.4	<9.4	115
00/2253	2.4	<9.4	<9.4	<9.4	241	<9.4	<9.4	270
00/2254	1.2	<9.4	<9.4	<9.4	298	<9.4	<9.4	113
00/2255	2.8	<9.4	<9.4	<9.4	123	<9.4	<9.4	42
00/2257	1.6	<9.4	<9.4	<9.4	223	<9.4	<9.4	101
00/2258	3.2	<9.4	<9.4	<9.4	2377	<9.4	<9.4	1194
00/2259	1.6	<9.4	<9.4	<9.4	433	<9.4	<9.4	71
00/2256	4	<9.4	<9.4	<9.4	303	<9.4	<9.4	84
00/2260	0.8	<9.4	<9.4	<9.4	4870	<9.4	<9.4	1520
00/2261	0.8	<9.4	<9.4	<9.4	1006	<9.4	<9.4	489
00/2262	2.4	<9.4	<9.4	<9.4	216	<9.4	<9.4	188
00/2263	1.6	<9.4	<9.4	<9.4	605	<9.4	<9.4	336
00/2264	1.6	<9.4	<9.4	<9.4	327	<9.4	<9.4	301
00/2265	1.6	<9.4	<9.4	<9.4	71	<9.4	<9.4	39
00/2266	3.6	<9.4	<9.4	<9.4	283	<9.4	<9.4	25
00/2267	1.2	<9.4	<9.4	<9.4	150	<9.4	<9.4	<9.4
00/2268	1.6	<9.4	<9.4	<9.4	624	<9.4	<9.4	846
	2.12							

	BDE99	**BDE85**	**BDE154**	**BDE153**	**BDE138**	**BDE190**	**BDE209**
00/2248	45	<9.4	35	32	<9.4	<9.4	<18
00/2250	401	<9.4	73	74	<9.4	<9.4	<18
00/2251	19	<9.4	21	8	<9.4	<9.4	<18
00/2252	80	<9.4	18	26	<9.4	<9.4	<18
00/2253	153	<9.4	90	230	<9.4	<9.4	<18
00/2254	173	<9.4	33	42	<9.4	<9.4	<18
00/2255	36	<9.4	12	10	<9.4	<9.4	<18
00/2257	74	<9.4	15	16	<9.4	<9.4	<18
00/2258	363	<9.4	293	162	<9.4	<9.4	<18
00/2259	48	<9.4	21	14	<9.4	<9.4	<18
00/2256	63	<9.4	30	29	<9.4	<9.4	<18
00/2260	225	<9.4	570	280	<9.4	<9.4	<18
00/2261	65	<9.4	<9.4	190	<9.4	<9.4	<18
00/2262	69	<9.4	78	31	<9.4	<9.4	<18
00/2263	451	<9.4	78	104	<9.4	<9.4	<18
00/2264	129	<9.4	81	72	<9.4	<9.4	<18
00/2265	<9.4	<9.4	16	<9.4	<9.4	<9.4	<18
00/2266	70	<9.4	9	8	<9.4	<9.4	<18
00/2267	<9.4	<9.4	<9.4	<9.4	<9.4	<9.4	<18
00/2268	132	<9.4	273	113	<9.4	<9.4	<18

BDE119

<9.4
<9.4
<9.4
<9.4
<9.4
<9.4
<9.4
<9.4
<9.4
<9.4
<9.4
45
<9.4
<9.4
<9.4
22
<9.4
<9.4
<9.4
16

Sum BDE (ex 209)

339
1291
454
473
984
659
223
429
4389
586
509
7510
1750
582
1574
933
125
395
150
2004

Annex 4.16. PBDE concentrations in Tees food chain samples

PBDEs in cormorant livers

µg/kg lipid weight

No.	%LIPID	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77	BDE100
00/2269	2.8	<8.7	<8.7	<8.7	40	<8.7	<8.7	30
00/2270	2.4	<8.7	<8.7	<8.7	149	<8.7	<8.7	134
00/2271	1.6	<8.7	41	<8.7	1779	<8.7	<8.7	1884
00/2272	1.6	<8.7	<8.7	<8.7	278	<8.7	<8.7	102
00/2273	4.4	<8.7	<8.7	<8.7	58	<8.7	<8.7	13
00/2274	1.6	<8.7	<8.7	<8.7	1294	<8.7	<8.7	409
00/2275	2	<8.7	<8.7	<8.7	140	<8.7	<8.7	84

	BDE99	BDE85	BDE154	BDE153	BDE138	BDE190	BDE209
00/2269	<8.7	<8.7	8	8	<8.7	<8.7	<17
00/2270	142	<8.7	43	33	<8.7	<8.7	<17
00/2271	348	<8.7	466	149	<8.7	<8.7	<17
00/2272	109	<8.7	34	33	<8.7	<8.7	<17
00/2273	17	<8.7	<8.7	<8.7	<8.7	<8.7	<17
00/2274	175	<8.7	92	70	<8.7	<8.7	<17
00/2275	53	<8.7	26	21	<8.7	<8.7	<17

Annex 5.1. PBDE concentrations in Western Scheldt food chain samples (WP 1)

PBDEs in biota (Terneuzen) (ug/kg wet weight)

	M. mesopodopsis (mysid shrimp)							M.schistomysis	M.gastrosaccus	Praunus	Copepods
	1	2	3	4	5	6	7	(mysid shrimp)	(mysid shrimp)		
BDE28	<0.09	<0.09	<0.07	<0.04	<0.07	<0.05	<0.06	<0.09	<0.1	<0.2	<0.08
BDE47	0.45	0.57	1.2	0.98	1.1	1.1	0.87	2.0	1.2	4.5	0.48
BDE66	<0.09	<0.09	<0.07	<0.04	<0.08	<0.05	<0.06	<0.09	<0.1	<0.2	<0.08
BDE71	<0.09	<0.09	<0.07	<0.04	<0.07	<0.05	<0.06	<0.09	<0.1	<0.2	<0.08
BDE75	<0.09	<0.09	<0.07	<0.04	<0.08	<0.05	<0.06	<0.09	<0.1	<0.2	<0.08
BDE77	<0.1	<0.1	<0.07	<0.04	<0.08	<0.06	<0.06	<0.1	<0.1	<0.2	<0.08
BDE85	<0.03	<0.03	<0.03	<0.02	0.02	<0.02	<0.02	<0.03	<0.04	<0.07	0.19
BDE99	0.21	0.28	0.60	0.54	0.61	0.56	0.46	1.5	0.93	2.3	<0.08
BDE100	0.10	0.11	0.23	0.20	0.20	0.21	0.17	0.46	0.30	1.1	0.07
BDE119	<0.09	<0.09	<0.07	<0.04	<0.07	<0.05	<0.06	<0.09	<0.1	<0.2	<0.08
BDE138	<0.09	<0.09	<0.07	<0.04	<0.07	<0.05	<0.06	<0.09	<0.1	<0.2	<0.08
BDE153	<0.1	<0.1	<0.07	<0.05	0.04	<0.06	<0.06	0.10	<0.1	0.29	<0.08
BB153+BDE154	<0.2	<0.23	<0.2	<0.1	<0.2	<0.1	<0.1	<0.2	<0.3	<0.5	<0.2
BDE190	<0.09	<0.09	<0.07	<0.04	<0.08	<0.05	<0.06	<0.09	<0.1	<0.2	<0.08
BDE209	<0.4	<0.4	<0.3	<0.2	<0.3	0.98	<0.3	<0.4	<0.5	<0.9	<0.3
HBCD	3.2	<4	5.4	4.1	5.0	4.6	3.8	2.6	7.2	11	2.7

PBDEs in biota (Terneuzen) (ug/kg fat)

	M. mesopodopsis (mysid shrimp)							M.schistomysis	M.gastrosaccus	Praunus	Copepods
	1	2	3	4	5	6	7	(mysid shrimp)	(mysid shrimp)		
Fat (g/kg):	8.1	9.1	12.2	9.6	11	10.5	8.7	10.3	9.4	14.9	9.3
BDE28	<12	<10	<5.7	<4.5	<6.8	<5.1	<6.6	<9.0	<11	<13	<8.2
BDE47	56	62	95	102	102	101	100	197	123	300	51
BDE66	<12	<10	<5.7	<4.5	<6.9	<5.1	<6.6	<9.1	<11	<13	<8.3
BDE71	<11	<10	<5.7	<4.5	<6.8	<5.1	<6.6	<9.0	<11	<13	<8.2
BDE75	<12	<10	<5.7	<4.5	<6.8	<5.1	<6.6	<9.0	<11	<13	<8.3
BDE77	<12	<11	<5.9	<4.7	<7.1	<5.3	<6.9	<9.4	<11	<14	<8.6
BDE85	<4.3	<3.8	<2.1	<1.7	1.6	<1.9	<2.5	<3.3	<4.1	<4.9	21
BDE99	26	31	50	56	56	53	53	149	99	157	<9.1
BDE100	12	13	19	21	18	20	20	45	32	76	8.0
BDE119	<11	<10	<5.6	<4.4	<6.7	<5.1	<6.5	<8.9	<11	<13	<8.2
BDE138	<11	<10	<5.6	<4.4	<6.7	<5.1	<6.5	<8.9	<11	<13	<8.2
BDE153	<12	<11	<6.0	<4.7	3.5	<5.4	<6.9	9.3	<12	20	<8.7
BB153+BDE154	<29	<25	<14	<11	<17	<13	<16	<22	<27	<33	<20
BDE190	<12	<10	<5.7	<4.5	<6.8	<5.1	<6.6	<9.0	<11	<13	<8.3
BDE209	<52	<46	<26	<20	<31	93	<30	<41	<50	<60	<37
HBCD	392	<430	443	428	455	437	436	250	765	717	290

BDE119
<8.7
<8.7
69
<8.7
<8.7
<8.7
<8.7

Sum BDE (ex 209)
85
500
4736
556
89
2040
323

ANNEX 5.2. PBDE concentrations in Western Scheldt food chain samples (WP 1)

PBDEs in biota (Terneuzen) (ug/kg wet weight)

	Gudgeon						Greater Sandeel		
	1	2	3	4	5	6	1	2	3
BDE28	0.21	0.32	0.44	0.60	0.66	0.69	0.13	0.10	0.17
BDE47	9.9	13	21	31	31	32	3.0	2.2	3.9
BDE66	0.20	0.13	0.38	0.36	0.44	0.56	<0.05	<0.05	<0.05
BDE71	<0.05	<0.06	<0.07	<0.08	<0.05	<0.03	<0.05	<0.05	<0.05
BDE75	<0.05	<0.06	<0.07	<0.08	<0.06	<0.03	0.07	<0.05	0.07
BDE77	<0.05	<0.06	<0.07	<0.08	<0.06	<0.03	<0.06	<0.05	<0.0
BDE85	<0.02	<0.02	<0.02	<0.03	<0.02	<0.01	<0.02	<0.02	<0.02
BDE99	4.2	5.9	7.6	10	12	12	0.22	0.12	0.34
BDE100	1.7	2.4	3.6	5.4	5.1	5.6	0.47	0.33	0.62
BDE119	<0.05	<0.06	<0.07	<0.08	<0.05	<0.03	<0.05	<0.04	<0.05
BDE138	<0.05	<0.06	<0.07	<0.08	<0.05	<0.03	<0.05	<0.04	<0.05
BDE153	0.63	0.79	1.3	1.7	1.9	2.0	0.11	0.10	0.16
BB153+BDE154	0.37	0.46	0.68	0.96	1.1	1.1	0.23	0.14	0.26
BDE190	<0.05	<0.06	<0.07	<0.08	<0.06	<0.03	<0.05	<0.05	<0.05
BDE209	<0.2	<0.3	<0.3	<0.4	<0.2	<0.1	<0.2	<0.2	<0.2
HBCD	16	22	28	43	57	63	20	18	21

PBDEs in biota (Terneuzen) (ug/kg fat)

	Gudgeon						Greater Sandeel		
	1	2	3	4	5	6	1	2	3
Fat (g/kg:)	17.2	18.6	19	21.3	22.6	20.8	11.1	11.4	11.9
BDE28	12	17	23	28	29	33	11	9.1	14
BDE47	577	724	1126	1473	1369	1536	269	192	327
BDE66	12	7.1	20	17	20	27	<4.9	<4.0	<3.9
BDE71	<3.0	<3.0	<3.5	<3.7	<2.4	<1.3	<4.8	<4.0	<3.9
BDE75	<3.1	<3.1	<3.5	<3.7	<2.4	<1.3	6.1	<4.0	5.8
BDE77	<3.2	<3.2	<3.6	<3.9	<2.5	<1.4	<5.0	<4.1	<4.1
BDE85	<1.1	<1.1	<1.3	<1.4	<0.9	<0.5	<1.8	<1.5	<1.5
BDE99	245	319	402	475	517	590	19	10	28
BDE100	100	128	192	253	227	267	42	29	52
BDE119	<3.0	<3.0	<3.5	<3.7	<2.4	<1.3	<4.8	<3.9	<3.9
BDE138	<3.0	<3.0	<3.5	<3.7	<2.4	<1.3	<4.8	<3.9	<3.9
BDE153	36	42	67	81	83	97	10	9.1	13
BB153+BDE154	22	25	36	45	49	53	21	12	22
BDE190	<3.1	<3.1	<3.5	<3.7	<2.4	<1.3	<4.9	<4.0	<3.9
BDE209	<14	<14	<16	<17	<11	<6.0	<22	<18	<18
HBCD	943	1205	1467	2032	2543	3048	1807	1609	1748

ANNEX 5.3. PBDE concentrations in Western Scheldt food chain samples (WP 1)

PBDEs in common tern eggs (Terneuzen) (ug/kg wet weight)

	2001/0003	2001/0004	2001/0005	2001/0006	2001/0007	2001/0008	2001/0009	2001/0010	2001/0011	2001/0012	2001/0013	2001/0014	2001/0015	2001/0016	2001/0017
BDE28	0.36	0.41	0.35	0.63	0.7	0.53	<0.12	0.44	0.50	0.3	<0.28	<0.28	0.13	0.29	<0.28
BDE47	11	19	10	21	22	18	11	20	23	8.3	6.7	6.7	11	12	7
BDE66	<0.13	<0.14	<0.13	<0.13	<0.13	<0.12	<0.12	<0.13	<0.14	<0.16	<0.28	<0.28	<0.28	<0.28	<0.28
BDE71	<0.13	<0.14	<0.13	<0.12	<0.13	<0.12	<0.12	<0.13	<0.14	<0.15	<0.28	<0.28	<0.27	<0.27	<0.28
BDE75	<0.13	<0.14	<0.13	<0.13	<0.13	<0.12	<0.12	<0.13	<0.14	<0.16	<0.28	<0.28	<0.28	<0.28	<0.28
BDE77	<0.13	<0.14	<0.14	<0.13	<0.14	<0.12	<0.13	<0.14	<0.15	<0.16	<0.29	<0.29	<0.29	<0.29	<0.29
BDE85	<0.11	<0.11	<0.11	<0.1	<0.11	<0.1	<0.10	<0.11	<0.12	<0.12	<0.1	<0.1	<0.1	<0.1	<0.1
BDE99	3.7	6.4	3	6.7	4.4	5.6	4.2	8.9	5.6	2.7	3.8	3.1	4.3	4.4	3.7
BDE100	2.6	4.7	2.6	4.9	4.8	4.8	2.8	6.0	6.0	2.2	2.3	1.6	3.4	3.9	2.3
BDE119	<0.13	<0.13	<0.13	<0.12	<0.13	<0.12	<0.12	<0.13	<0.14	<0.15	<0.28	<0.28	<0.27	<0.27	<0.27
BDE138	<0.13	<0.13	<0.13	<0.12	<0.13	<0.12	<0.12	<0.13	<0.14	<0.15	<0.28	<0.28	<0.27	<0.27	<0.27
BDE153	14	16	8	12	6.7	14	18	24	9.2	5.0	12	6.5	10	9.3	16
BB153+BDE154	2.5	2.8	1.5	2.4	2.2	2.1	3.6	3.9	3.4	1.7	2.5	0.35	1.6	0.9	3.1
BDE190	<0.28	<0.29	<0.29	<0.27	<0.29	<0.26	<0.27	<0.29	<0.31	<0.33	<0.28	<0.28	<0.28	<0.28	<0.28
BDE209	<0.52	<0.55	0.55	1.4	0.84	0.45	<0.50	<0.54	2.9	<0.62	<1.3	<1.3	<1.2	<1.2	<1.3
HBCD	55	29	57	32	34	87	53	350	51	25	58	12	13	38	22

PBDEs in common tern eggs (Terneuzen) (ug/kg fat)

	2001/0003	2001/0004	2001/0005	2001/0006	2001/0007	2001/0008	2001/0009	2001/0010	2001/0011	2001/0012	2001/0013	2001/0014	2001/0015	2001/0016	2001/0017
Fat ug/kg:	104	94	94	108	109	102	105	91	108	108	101	96	110	105	109
BDE28	3.5	4.4	3.7	5.8	6.4	5.2	<1.2	4.8	4.6	2.8	<2.8	<2.9	1.2	2.8	<2.5
BDE47	106	202	106	194	202	176	105	220	213	77	66	70	100	114	64
BDE66	<1.2	<1.4	<1.4	<1.2	<1.2	<1.2	<1.2	<1.5	<1.3	<1.4	<2.8	<2.9	<2.5	<2.6	<2.6
BDE71	<1.2	<1.4	<1.4	<1.2	<1.2	<1.2	<1.2	<1.5	<1.3	<1.5	<2.8	<2.9	<2.5	<2.6	<2.5
BDE75	<1.2	<1.4	<1.4	<1.2	<1.2	<1.2	<1.2	<1.5	<1.3	<1.6	<2.8	<2.9	<2.5	<2.6	<2.6
BDE77	<1.3	<1.5	<1.5	<1.2	<1.3	<1.2	<1.2	<1.5	<1.4	<1.7	<2.9	<3.0	<2.6	<2.7	<2.6
BDE85	<1.0	<1.2	<1.2	<0.97	<1.0	<0.98	<0.98	<1.2	<1.1	<1.2	<1.0	<1.1	<0.93	<0.97	<0.95
BDE99	36	68	33	62	40	55	40	98	52	25	38	32	39	42	34
BDE100	25	50	28	45	44	47	27	66	56	20	23	17	31	37	21
BDE119	<1.2	<1.4	<1.4	<1.1	<1.2	<1.2	<1.2	<1.4	<1.3	<1.4	<2.8	<2.9	<2.5	<2.6	<2.5
BDE138	<1.2	<1.4	<1.4	<1.1	<1.2	<1.2	<1.2	<1.4	<1.3	<1.5	<2.8	<2.9	<2.5	<2.6	<2.5
BDE153	135	170	85	111	61	137	171	264	85	46	119	68	91	89	147
BB153+BDE154	24	30	16	22	19	21	34	43	31	16	25	3.6	15	8.6	28
BDE190	<2.7	<3.1	<3.1	<2.5	<2.6	<2.5	<2.5	<3.2	<2.8	<3.0	<2.8	<2.9	<2.5	<2.6	<2.6
BDE209	<5.0	<5.9	5.9	13	7.6	4.4	<4.8	<6.0	27	<5.8	<13	<13	<11	<12	<12
HBCD	529	309	606	306	312	853	505	3846	472	231	574	125	118	362	202

Annex 5.4. Flame retardannts in common tern eggs from the Maasvlakte

Maasvlakte

ug/kg total weight

	2001/0018	2001/0019	2001/0020	2001/0021	2001/0022	2001/0023	2001/0024	2001/0025	2001/0026	2001/0027	2001/0028	2001/0029	2001/0030	2001/0031	2001/0032
BDE 28	0.83	0.95	0.81	0.72	1.2	1.3	0.96	0.86	1.0	1.0	1.4	0.79	0.55	0.89	1.8
BDE 47	29	32	44	32	39	54	26	32	44	36	46	22	21	30	50
BDE 66	<0.13	0.59	<0.13	<0.14	<0.11	<0.14	0.32	<0.13	<0.14	<0.13	<0.28	<0.27	0.24	0.32	0.88
BDE 71	<0.13	<0.13	<0.13	<0.14	<0.11	<0.14	<0.28	<0.13	<0.14	<0.13	<0.28	<0.27	<0.27	<0.28	<0.28
BDE 75	<0.13	0.68	<0.13	<0.14	<0.11	<0.14	<0.28	<0.13	<0.14	<0.13	<0.28	<0.27	<0.28	<0.28	<0.29
BDE 77	<0.13	<0.14	<0.14	<0.14	<0.12	<0.14	<0.29	<0.13	<0.14	<0.14	<0.29	<0.28	<0.29	<0.29	<0.3
BDE 85	<0.11	<0.11	<0.11	<0.11	<0.10	<0.11	<0.1	<0.11	<0.11	<0.11	<0.1	<0.1	<0.1	<0.1	0.99
BDE 99	9.6	7.0	24	11	9.6	27	8.6	14	16	20	16	6.6	8.7	11	28
BDE 100	7.4	8.1	14	10	9.4	16	8.4	8.5	9.8	11	15	7.0	6.6	11	17
BDE 119	<0.13	<0.13	<0.13	<0.13	<0.11	<0.14	<0.28	<0.13	<0.14	<0.13	<0.28	<0.27	<0.27	<0.27	<0.28
BDE 138	<0.13	<0.13	<0.13	<0.13	<0.11	<0.14	<0.28	<0.13	<0.14	<0.13	<0.28	<0.27	<0.27	<0.27	<0.28
BDE 153	<0.13	3.1	9.4	4.3	3.6	14	2.0	3.9	4.1	6.6	9.3	2.8	2.5	5.8	13
BB 153+BDE 154	2.1	2.4	4.1	2.2	2.5	5.4	1.1	2.3	1.8	3.7	4.2	1.6	0.81	3.1	7.9
BDE 190	<0.28	<0.29	<0.28	<0.29	<0.24	<0.30	<0.28	<0.28	<0.30	<0.28	<0.28	<0.27	<0.28	<0.28	<0.29
BDE 209	<0.52	<0.54	7.1	<0.56	<0.46	<0.56	<1.3	<0.52	<0.56	<0.54	<1.3	<1.2	<1.2	<1.3	<1.3
HBCD	<0.31	11	5.0	6.0	7.5	10	3.5	11	7.6	6.9	7.4	4.5	2.5	5.5	39

ug/kg lipid weight

	2001/0018	2001/0019	2001/0020	2001/0021	2001/0022	2001/0023	2001/0024	2001/0025	2001/0026	2001/0027	2001/0028	2001/0029	2001/0030	2001/0031	2001/0032
Fat conc. %	80	85	102	86	83	88	107	92	98	92	108	89	104	91	105
BDE 28	10	11	7.9	8.5	14	15	9.0	9.3	11	11	13	8.9	5.3	9.8	17
BDE 47	363	376	431	372	470	614	243	348	449	391	426	247	202	330	472
BDE 66	<1.6	6.9	<1.3	<1.6	<1.4	<1.5	3.0	<1.4	<1.4	<1.4	<2.6	<3.1	2.3	3.5	8.4
BDE 71	<1.6	<1.5	<1.3	<1.6	<1.4	<1.5	<2.6	<1.4	<1.4	<1.4	<2.6	<3.0	<2.6	<3.0	<2.7
BDE 75	<1.6	8.0	<1.3	<1.6	<1.4	<1.6	<2.6	<1.4	<1.4	<1.4	<2.6	<3.1	<2.7	<3.1	<2.7
BDE 77	<1.7	<1.6	<1.3	<1.6	<1.4	<1.6	<2.7	<1.4	<1.4	<1.5	<2.7	<3.2	<2.8	<3.2	<2.8
BDE 85	<1.3	<1.3	<1.1	<1.3	<1.1	<1.3	<0.97	<1.2	<1.2	<1.2	<0.97	<1.1	<0.98	<1.1	9.4
BDE 99	120	82	235	128	116	307	80	152	158	217	148	74	84	121	267
BDE 100	93	95	137	116	113	182	79	92	101	120	139	79	63	121	162
BDE 119	<1.6	<1.5	<1.3	<1.6	<1.4	<1.5	<2.6	<1.4	<1.4	<1.4	<2.6	<3.0	<2.6	<3.0	<2.7
BDE 138	<1.6	<1.5	<1.3	<1.6	<1.4	<1.5	<2.6	<1.4	<1.4	<1.4	<2.6	<3.0	<2.6	<3.0	<2.7
BDE 153	<1.7	36	92	50	43	159	19	42	42	72	86	31	24	64	124
BB 153+BDE 154	26	28	40	26	30	61	10	25	18	40	39	18	7.8	34	75
BDE 190	<3.5	<3.4	<2.8	<3.4	<3.0	<3.4	<2.6	<3.0	<3.1	<3.1	<2.6	<3.1	<2.7	<3.1	<2.7
BDE 209	<6.5	<6.4	70	<6.5	<5.6	<6.4	<12	<5.7	<5.7	<5.8	<12	<14	<12	<14	<12
HBCD	<3.9	129	49	71	90	114	33	120	77	75	75	51	24	60	368

ANNEX 6.1. PBDE concentrations in Western Scheldt sediments (WP 2)

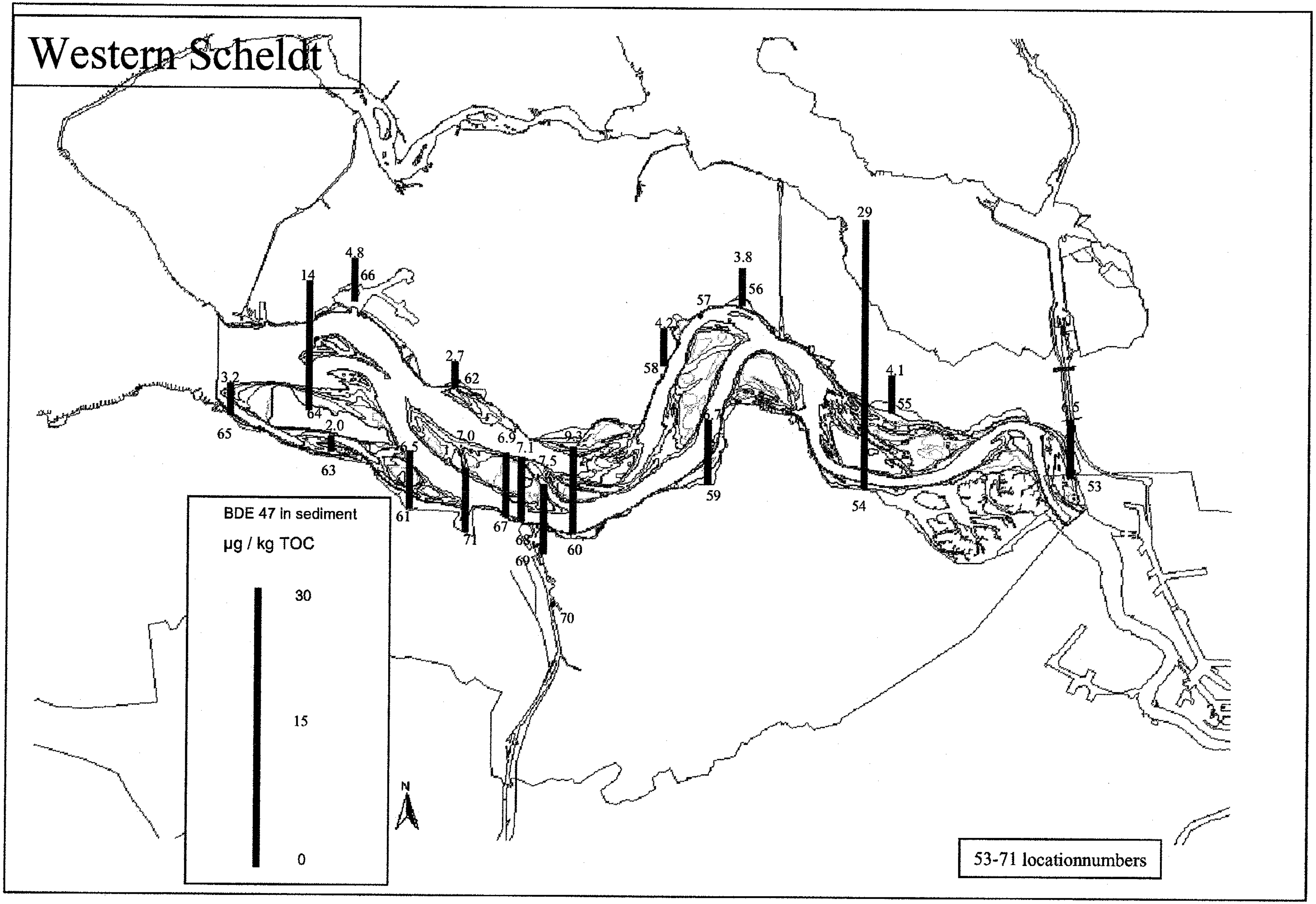
ug/kg dry weight

location no.:	66	62	58	57	56	55	64	68	53	54	59	60	67	69	70	71	61	63	65
% dry weight:	66.0	44.4	49.6	43.6	43.5	46.8	61.6	40.6	37.5	69.7	59.2	63.9	63.1	52.8	66.9	71.5	72.8	47.8	59.2
BDE28	<0.12	<0.19	<0.17	<0.39	<0.19	<0.17	<0.25	<0.39	<0.42	<0.11	<0.14	<0.12	<0.12	<0.15	<0.12	<0.11	<0.11	<0.18	<0.13
BDE47	<0.07	<0.14	<0.19	<0.22	<0.24	<0.23	0.32	0.69	0.77	0.08	0.17	0.14	0.13	0.24	<0.13	0.05	0.05	0.10	0.08
BDE66	<0.12	<0.19	<0.17	<0.39	<0.20	<0.18	<0.25	<0.39	<0.43	<0.11	<0.14	<0.12	<0.12	<0.15	<0.12	<0.11	<0.11	<0.18	<0.13
BDE71	<0.12	<0.19	<0.17	<0.19	<0.19	<0.17	<0.12	<0.19	<0.21	<0.11	<0.14	<0.12	<0.12	<0.15	<0.12	<0.11	<0.11	<0.18	<0.13
BDE75	<0.12	<0.19	<0.17	<0.20	<0.20	<0.18	<0.13	<0.20	<0.21	<0.11	<0.14	<0.12	<0.12	<0.15	<0.12	<0.11	<0.11	<0.18	<0.13
BDE77	<0.12	<0.20	<0.18	<0.40	<0.20	<0.18	<0.26	<0.41	<0.44	<0.12	<0.14	<0.13	<0.12	<0.15	<0.12	<0.12	<0.11	<0.18	<0.14
BDE85	<0.04	<0.07	<0.06	<0.72	<0.07	<0.07	<0.46	<0.73	<0.79	<0.04	<0.05	<0.05	<0.04	<0.05	<0.04	<0.04	<0.04	<0.07	<0.05
BDE99	1.04	0.08	0.12	<0.21	0.17	0.18	0.28	0.57	0.71	0.02	0.10	0.08	0.07	0.17	<0.13	0.03	<0.12	0.08	0.03
BDE100	<0.12	<0.20	<0.18	<0.20	<0.20	<0.18	<0.13	0.35	<0.22	<0.12	<0.14	<0.13	<0.12	<0.15	<0.12	<0.12	<0.11	<0.18	<0.14
BDE119	<0.12	<0.19	<0.17	<0.19	<0.19	<0.17	<0.12	<0.19	<0.21	<0.11	<0.14	<0.12	<0.12	<0.14	<0.11	<0.11	<0.11	<0.17	<0.13
BDE138	<0.12	<0.19	<0.17	<0.38	<0.19	<0.17	<0.25	<0.39	<0.42	<0.11	<0.14	<0.12	<0.12	<0.14	<0.11	<0.11	<0.11	<0.17	<0.13
BDE153	0.06	0.11	0.20	0.34	0.46	0.27	0.31	0.74	0.86	0.11	0.19	0.16	0.11	0.24	<0.12	0.07	<0.11	<0.19	0.10
BB153+BDE154	0.02	<0.47	0.05	<0.48	<0.48	<0.43	<0.31	<0.48	<0.52	<0.28	<0.34	<0.3	<0.29	0.04	<0.29	<0.28	<0.26	<0.44	<0.33
BDE190	<0.12	<0.19	<0.17	<0.78	<0.20	<0.18	<0.50	<0.78	<0.85	<0.11	<0.14	<0.12	<0.12	<0.15	<0.12	<0.11	<0.11	<0.18	<0.13
BDE209	31	98	98	110	299	302	280	771	916	116	60	34	38	48	12	21	5.3	31	19
HBCD	4.0	12	15	3.6	40	37	18	74	93	10	8.7	10	6.7	7.5	1.3	4.6	<0.11	6.2	6.3

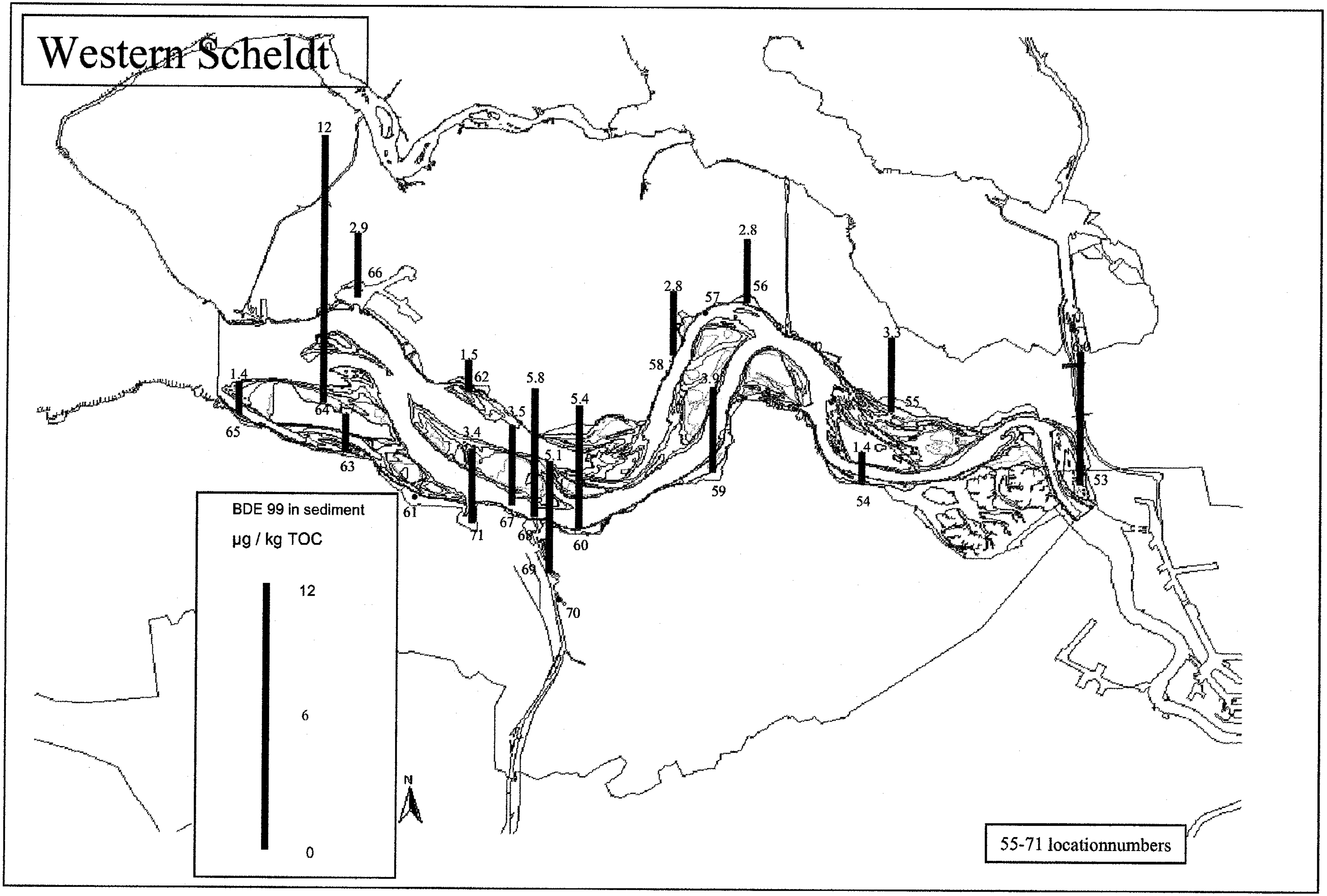
ug/kg TOC

location no:.	66	62	58	57	56	55	64	68	53	54	59	60	67	69	70	71	61	63	65
% TOC:	0.98	2.34	2.2	1.98	2.71	2.61	1.42	3.95	4.45	0.87	1.51	0.98	1.18	1.7	0.75	0.54	0.52	2.33	1.4
BDE28	<8.0	<3.6	<3.9	<8.5	<3.1	<3.1	<11	<4.0	<3.6	<9	<5.3	<7.9	<6.2	<4.5	<10	<15	<15	<3.6	<5.6
BDE47	4.8	2.7	4.2	<4.8	3.8	4.1	14	7.1	6.5	6.2	6.7	9.3	6.9	7.5	<12	7.0	6.5	2.0	3.2
BDE66	<8.1	<3.6	<3.9	<8.6	<3.1	<3.2	<11	<4.0	<3.6	<9.1	<5.4	<8	<6.3	<4.6	<10	<15	<15	<3.6	<5.7
BDE71	<8.0	<3.6	<3.9	<4.3	<3.1	<3.1	<5.4	<2.0	<1.8	<9	<5.3	<7.9	<6.2	<4.5	<10	<15	<15	<3.6	<5.6
BDE75	<8.1	<3.6	<3.9	<4.3	<3.1	<3.2	<5.5	<2.0	<1.8	<9.1	<5.4	<8	<6.3	<4.5	<10	<15	<15	<3.6	<5.6
BDE77	<8.4	<3.8	<4	<8.9	<3.2	<3.3	<11	<4.2	<3.7	<9.4	<5.6	<8.3	<6.5	<4.7	<11	<16	<16	<3.8	<5.8
BDE85	<3.0	<1.3	<1.4	<16	<1.2	<1.2	<20	<7.5	<6.6	<3.4	<2	<3	<2.3	<1.7	<3.9	<5.6	<5.5	<1.3	<2.1
BDE99	2.9	1.5	2.8	<4.7	2.8	3.3	12	5.8	6.0	1.4	3.9	5.4	3.5	5.1	<11	3.4	<16	1.7	1.4
BDE100	<8.3	<3.7	<4	<4.4	<3.2	<3.3	<5.6	3.6	<1.8	<9.3	<5.5	<8.2	<6.4	<4.7	<11	<15	<15	<3.7	<5.8
BDE119	<8.0	<3.6	<3.8	<4.2	<3.1	<3.1	<5.4	<2.0	<1.8	<8.9	<5.3	<7.9	<6.2	<4.5	<10	<15	<15	<3.6	<5.6
BDE138	<8.0	<3.6	<3.8	<8.5	<3.1	<3.1	<11	<4.0	<3.5	<8.9	<5.3	<7.9	<6.2	<4.5	<10	<15	<15	<3.6	<5.6
BDE153	4.0	2.1	4.5	7.6	7.4	4.9	13	7.6	7.2	<8.4	7.5	11	5.7	7.5	<11	8.7	<16	<3.8	<4
BB153+BDE154	1.1	<8.9	<1.1	<11	<7.7	<7.8	<13	<5.0	<4.4	<22	<13	<20	<15	<1.1	<26	<37	<37	<9	<14
BDE190	<8.4	<3.6	<3.9	<17	<3.1	<3.2	<22	<8.1	<7.2	<9.1	<5.4	<8	<6.3	<4.5	<10	<15	<15	<3.6	<5.6
BDE209	2069	1860	2201	2412	4802	5422	12145	7922	7716	9301	2355	2194	2059	1505	1110	2719	736	630	808
HBCD	270	227	329	80	637	667	780	762	780	840	343	659	357	233	119	611	<16	127	267

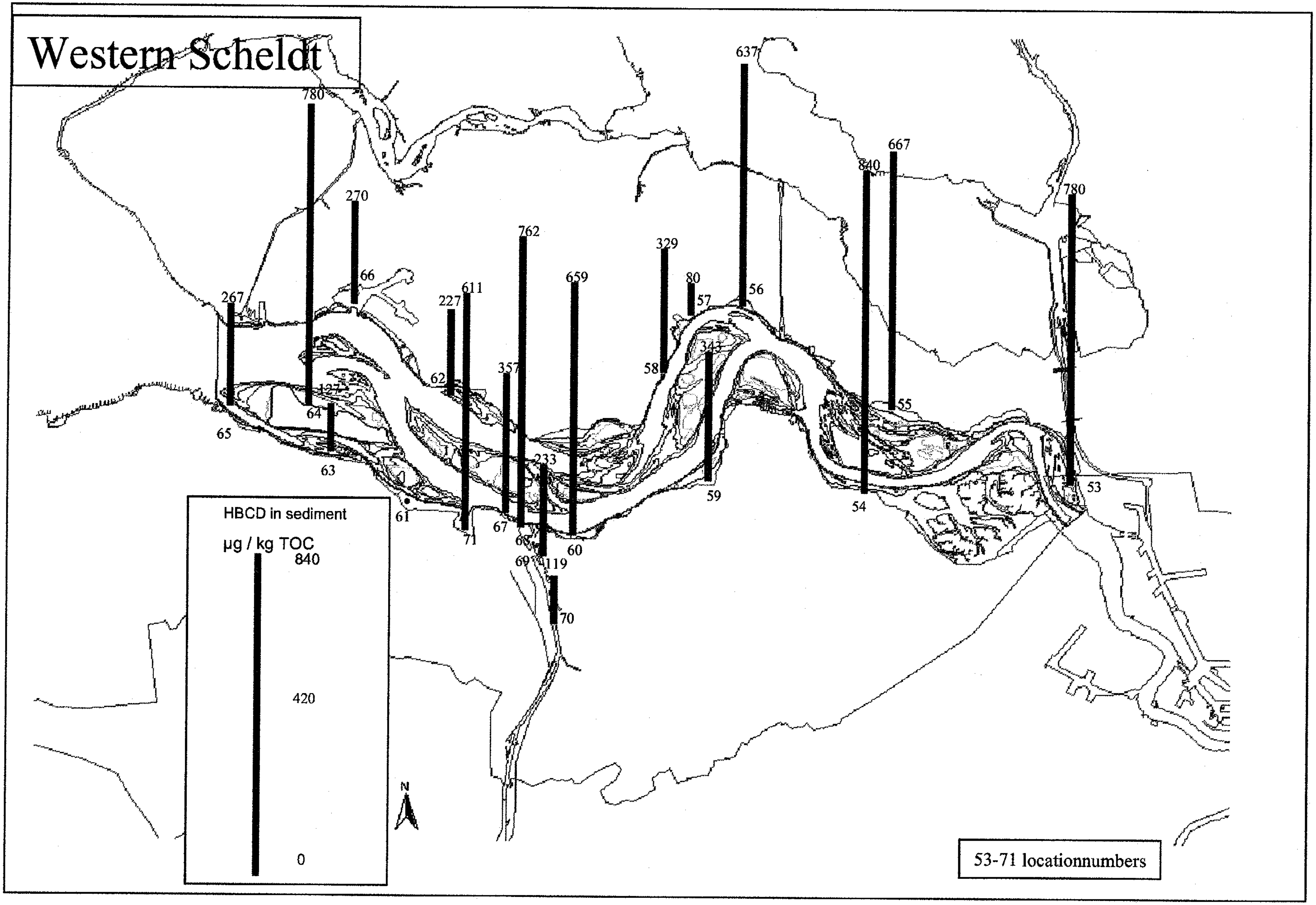
Annex 6.2.


Western Scheldt
BDE 47 in sediment
µg / kg TOC
30
15
0
N
53-71 locationnumbers
3.2
65
14
64
4.8
66
2.0
63
2.7
62
7.0
71
61
6.9
67
7.1
68
7.5
69
70
9.3
60
4.2
58
57
3.8
56
59
29
54
4.1
55
53

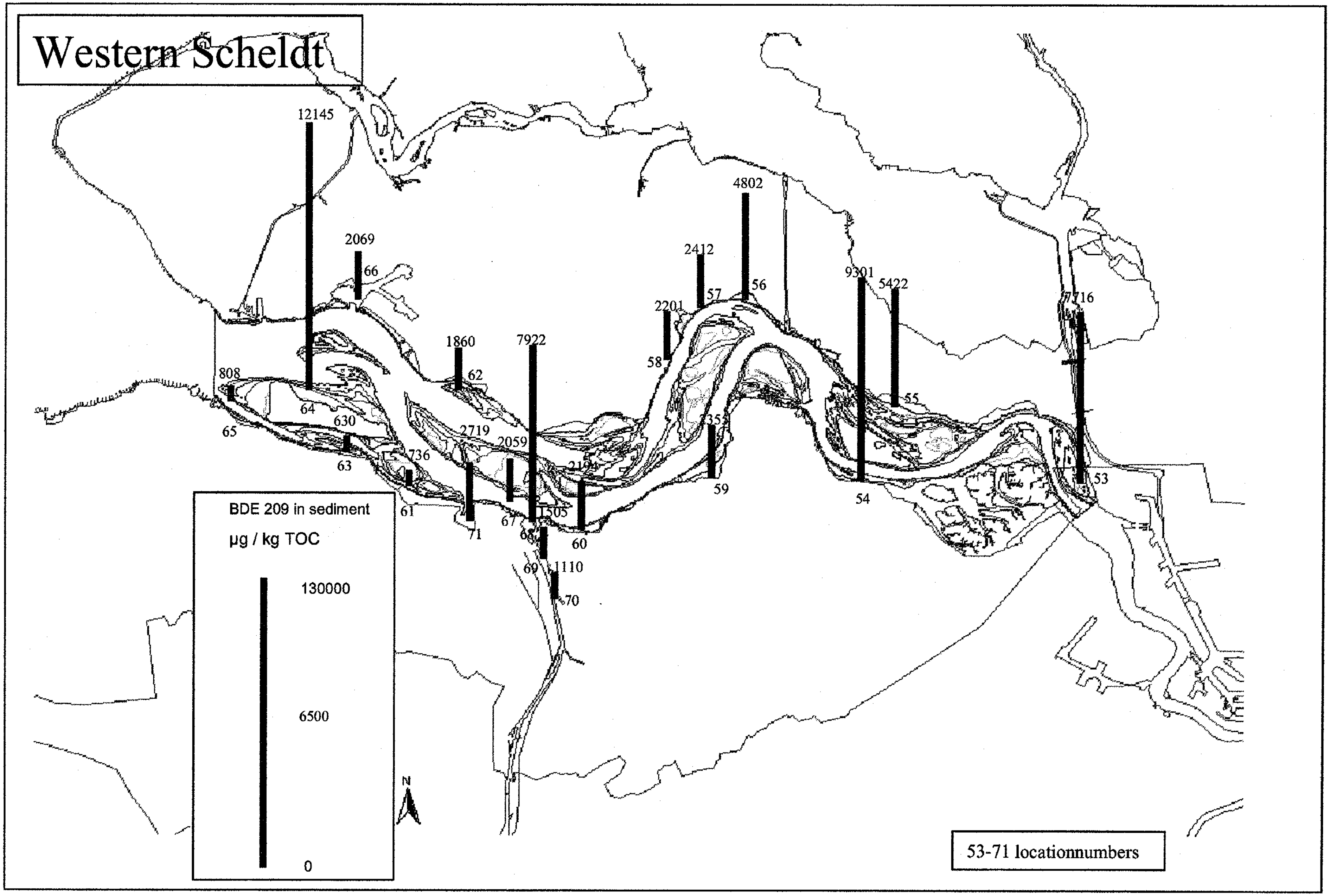
Annex 6.3.


Western Scheldt
BDE 99 in sediment
µg / kg TOC
12
6
0
N
55-71 locationnumbers
12
2.9
66
64
65
1.4
63
61
1.5
62
3.4
71
3.5
67
5.8
68
5.1
69
70
5.4
60
2.8
58
57
2.8
56
3.9
59
3.3
55
1.4
54
53

Annex 6.4.


Western Scheldt
HBCD in sediment
µg / kg TOC
840
420
0
N
53-71 locationnumbers
780
270
267
66
227
611
762
659
329
80
57
637
56
840
667
780
62
357
343
58
127
233
119
70
55
53
54
59
60
61
63
64
65
67
68
69
71

Annex 6.5



Western Scheldt
12145
2069
66
2412
4802
9301
5422
7716
57
56
2201
58
1860
62
7922
808
65
64
630
63
736
61
2719
2059
71
67
60
69
1110
70
59
54
55
53
BDE 209 in sediment
µg / kg TOC
130000
6500
0
N
53-71 locationnumbers

Annex 7.1. PBDE concentrations in Tees sediment

Upper Tees (Cow Green reservoir to Croft on Tees) µg/kg dry weight (<2000µm)

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71	BDE47	BDE66
00/2590	54.67235	-2.231033	Langdon Becl	<0.2	<0.2	<0.2	0.2	<0.2
00/2591	54.62155	-2.081283	R.Tees at Mic	<0.2	<0.2	<0.2	0.2	<0.2
00/2592	54.603683	-2.00655	R.Tees at Eg(	<0.2	<0.2	<0.2	<0.2	<0.2
00/2593	54.528283	-1.892683	R.Tees at Abl	<0.2	<0.2	<0.2	<0.2	<0.2
00/2594	54.541433	-1.778817	R.Tees at Wir	<0.2	<0.2	<0.2	0.36	<0.2
00/2595	54.535	-1.674183	R.Tees at Pie	<0.2	<0.2	<0.2	0.27	<0.2

				BDE99	BDE85	BDE154	BDE153	BDE138
00/2590	54.67235	-2.231033	Langdon Becl	<0.2	<0.2	<0.2	<0.2	<0.2
00/2591	54.62155	-2.081283	R.Tees at Mic	<0.2	<0.2	<0.2	<0.2	<0.2
00/2592	54.603683	-2.00655	R.Tees at Eg(	<0.2	<0.2	<0.2	<0.2	<0.2
00/2593	54.528283	-1.892683	R.Tees at Abl	<0.2	<0.2	<0.2	<0.2	<0.2
00/2594	54.541433	-1.778817	R.Tees at Wir	0.3	<0.2	<0.2	<0.2	<0.2
00/2595	54.535	-1.674183	R.Tees at Pie	<0.2	<0.2	<0.2	<0.2	<0.2

BDE77	BDE100	BDE119
<0.2	<0.2	<0.2
<0.2	<0.2	<0.2
<0.2	<0.2	<0.2
<0.2	<0.2	<0.2
<0.2	<0.2	<0.2
<0.2	<0.2	<0.2

BDE190	BDE209	Sum BDE (ex 209)
<0.2	<0.2	<0.2
<0.2	<0.2	<0.2
<0.2	<0.2	<0.2
<0.2	0.6	<0.2
<0.2	2	1
<0.2	<0.2	<0.2

Annex 7.2. PBDE concentrations in Tees sediment

Middle Tees (Croft on Tees to Tees Barrage) µg/kg dry weight (<2000µm)

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77
00/2596	54.486033	-1.56215	R.Tees upstı	<0.2	<0.2	<0.2	0.21	<0.2	<0.2
00/2597	54.479533	-1.552417	R.Tees dowı	0.51	0.27	15	12	0.38	0.25
00/2605	54.48435	-1.5197	R.Tees at Hı	<0.2	<0.2	<0.2	2	<0.2	<0.2
00/2604	54.492233	-1.409167	R.Tees at Nε	<0.2	<0.2	<0.2	0.94	0.44	<0.2
00/2603	54.512117	-1.353983	R.Tees at Yε	<0.2	<0.2	<0.2	2.1	<0.2	0.12
00/2601	54.537083	-1.32875	R.Tees at Prı	<0.20	<0.2	0.23	0.74	<0.2	<0.2
00/2602	54.499717	-1.31495	R.Leven at L	0.51	<0.2	<0.2	8.9	0.74	<0.2

No.	Latitude	Longitude	Location	BDE99	BDE85	BDE154	BDE153	BDE138	BDE190
00/2596	54.486033	-1.56215	R.Tees upstı	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
00/2597	54.479533	-1.552417	R.Tees dowı	25	1.2	2.1	4.2	0.47	0.71
00/2605	54.48435	-1.5197	R.Tees at Hı	2.5	<0.2	<0.2	<0.2	<0.2	<0.2
00/2604	54.492233	-1.409167	R.Tees at Nε	0.42	<0.2	<0.2	<0.2	<0.2	<0.2
00/2603	54.512117	-1.353983	R.Tees at Yε	2.1	<0.2	0.25	0.31	<0.2	<0.2
00/2601	54.537083	-1.32875	R.Tees at Prı	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
00/2602	54.499717	-1.31495	R.Leven at L	19	0.71	0.96	2.1	0.31	0.45

BDE100	BDE119
<0.2	<0.2
3.4	7.4
0.33	<0.2
0.11	<0.2
0.38	<0.2
0.14	<0.2
1.3	5.4

BDE209	Sum BDE (ex 209)
1	<0.2
107	73
<0.2	5
0.8	2
4.8	5
<0.05	1
<0.05	40

Annex 7.3. PBDE concentrations in Tees sediment

Lower Tees (Tees Barrage to Tees Mouth) µg/kg dry weight (<2000µm)

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77
00/2600	54.565383	-1.285767	R.Tees upstı	0.3	<0.2	<0.2	4.2	0.32	<0.2
00/2340	54.59	-1.143333	Bamlett's Wh	1.5	<0.2	<0.2	13.3	1.5	<0.2
00/2341	54.590667	-1.243333	Bamlett's Big	1.2	<0.2	<0.2	16.9	0.8	<0.2
00/2342	54.5915	-1.242667	Bamlett's Big	1.9	<0.2	0.9	14.7	0.9	<0.2
00/2343	54.5875	-1.236667	Middlesbrou	0.3	<0.2	0.7	2.9	<0.2	<0.2
00/2344	54.588	-1.236	Middlesbrou	0.42	<0.2	0.68	1.9	<0.2	<0.2
00/2345	54.584667	-1.226	Tees Transp	1.1	0.33	6.6	8.8	1.3	<0.2
00/2346	54.585	-1.224167	Tees Transp	2.3	0.53	2.4	<0.2	<0.2	0.11
00/2347	54.581333	-1.2105	Tees Storage	1.9	<0.2	9.3	12	2	<0.2
00/2348	54.583833	-1.1845	Cargo Fleet \	0.4	<0.2	0.5	2.9	0.5	<0.2
00/2349	54.584667	-1.196167	Cargo Fleet '	1.1	<0.2	5.1	8.4	<0.2	<0.2
00/2350	54.5875	-1.186667	No. 25 Buoy	1.9	<0.2	6.7	0.46	2	<0.2
00/2351	54.588167	-1.187667	No. 25 Buoy	1.3	<0.2	ND	6.2	<0.2	<0.2
00/2353	54.589167	-1.189667	No. 25 Buoy	0.99	<0.05	3.5	3.9	0.2	<0.05
00/2352	54.597333	-1.10068	ICI North Tee	1.8	0.26	6.5	11	2.3	0.11

No.	Latitude	Longitude	Location	BDE99	BDE85	BDE154	BDE153	BDE138	BDE190
00/2600	54.565383	-1.285767	R.Tees upstı	7.2	0.17	0.62	0.89	0.13	<0.2
00/2340	54.59	-1.143333	Bamlett's Wh	17	0.9	1.1	1.7	0.3	<0.2
00/2341	54.590667	-1.243333	Bamlett's Big	28	1.1	4	4.4	0.4	<0.2
00/2342	54.5915	-1.242667	Bamlett's Big	18	0.9	5.3	4.7	0.5	<0.2
00/2343	54.5875	-1.236667	Middlesbrou	16.0	0.6	4.9	3.9	0.4	<0.2
00/2344	54.588	-1.236	Middlesbrou	1.8	0.19	0.69	0.56	<0.2	<0.2
00/2345	54.584667	-1.226	Tees Transp	14.7	0.26	<0.2	2.4	0.33	<0.2
00/2346	54.585	-1.224167	Tees Transp	16.4	0.22	5.6	<0.2	<0.2	<0.2
00/2347	54.581333	-1.2105	Tees Storage	16	0.23	3.2	3.4	<0.2	<0.2
00/2348	54.583833	-1.1845	Cargo Fleet \	4.9	0.29	0.42	0.61	0.21	<0.2
00/2349	54.584667	-1.196167	Cargo Fleet '	<0.2	0.28	1.78	2.1	<0.2	<0.2
00/2350	54.5875	-1.186667	No. 25 Buoy	<0.2	0.2	2.4	2.7	0.25	<0.2
00/2351	54.588167	-1.187667	No. 25 Buoy	2.7	<0.2	0.8	1.3	<0.2	<0.2
00/2353	54.589167	-1.189667	No. 25 Buoy	<0.05	0.26	1.2	0.91	0.08	<0.05
00/2352	54.597333	-1.10068	ICI North Tee	0.08	1.1	1.81	2.36	0.39	<0.05

BDE100	BDE119
0.68	<0.2
1.4	<0.2
4.3	<0.2
3.8	<0.2
<0.2	<0.2
<0.2	0.33
2	0.56
<0.2	3.5
<0.2	<0.2
0.3	0.34
1.1	0.25
0.79	0.7
ND	ND
<0.05	0.29
1.9	0.36

BDE209	Sum BDE (ex 209)
10.3	15
76	39
378	61
74	52
13	30
28	7
164	38
177	31
306	48
119	11
140	20
165	18
55	12
55	11
327	30

Annex 7.4. PBDE concentrations in Tees sediment

Lower Tees (Tees Barrage to Tees Mouth) µg/kg TOC

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77
00/2600	54.565383	-1.285767	R.Tees upstr	5.3	<3.2	<3.2	74.1	5.6	<3.2
00/2340	54.59	-1.143333	Bamlett's Wh	26.4	<3.2	<3.2	233.7	26.4	<3.2
00/2341	54.590667	-1.243333	Bamlett's Big	23.4	<3.2	<3.2	329.4	15.6	<3.2
00/2342	54.5915	-1.242667	Bamlett's Big	20.6	<3.2	9.8	159.3	9.8	<3.2
00/2343	54.5875	-1.236667	Middlesbrou(	31.5	<3.2	14.9	243.4	14.9	<3.2
00/2344	54.588	-1.236	Middlesbrou(	10.2	<3.2	16.5	46.0	<3.2	<3.2
00/2345	54.584667	-1.226	Tees Transp	16.6	5.0	99.5	132.7	19.6	<3.2
00/2346	54.585	-1.224167	Tees Transp	37.8	8.7	39.4	<3.2	<3.2	1.8
00/2347	54.581333	-1.2105	Tees Storage	29.4	<3.2	144.0	185.8	31.0	<3.2
00/2348	54.583833	-1.1845	Cargo Fleet \	12.9	<3.2	16.1	93.5	16.1	<3.2
00/2349	54.584667	-1.196167	Cargo Fleet '	17.1	<3.2	79.4	130.8	<3.2	<3.2
00/2350	54.5875	-1.186667	No. 25 Buoy	26.8	<3.2	94.4	6.5	28.2	<3.2
00/2351	54.588167	-1.187667	No. 25 Buoy	17.7	<3.2	<3.2	84.5	<3.2	<3.2
00/2353	54.589167	-1.189667	No. 25 Buoy	14.8	<3.2	52.4	58.4	3.0	<3.2
00/2352	54.597333	-1.10068	ICI North Tee	24.2	3.5	87.5	148.0	31.0	1.5

No.	Latitude	Longitude	Location	BDE99	BDE85	BDE154	BDE153	BDE138	BDE190
00/2600	54.565383	-1.285767	R.Tees upstr	127.0	3.0	10.9	15.7	2.3	<3.2
00/2340	54.59	-1.143333	Bamlett's Wh	298.8	15.8	19.3	29.9	5.3	<3.2
00/2341	54.590667	-1.243333	Bamlett's Big	545.8	21.4	78.0	85.8	7.8	<3.2
00/2342	54.5915	-1.242667	Bamlett's Big	195.0	9.8	57.4	50.9	5.4	<3.2
00/2343	54.5875	-1.236667	Middlesbrou(	#REF!	14.9	87.7	77.8	8.3	<3.2
00/2344	54.588	-1.236	Middlesbrou(	43.6	4.6	16.7	13.6	<3.2	<3.2
00/2345	54.584667	-1.226	Tees Transp	221.7	3.9	<3.2	36.2	5.0	<3.2
00/2346	54.585	-1.224167	Tees Transp	269.3	3.6	92.0	<3.2	<3.2	<3.2
00/2347	54.581333	-1.2105	Tees Storage	247.7	3.6	49.5	52.6	<3.2	<3.2
00/2348	54.583833	-1.1845	Cargo Fleet \	158.1	9.4	13.5	19.7	6.8	<3.2
00/2349	54.584667	-1.196167	Cargo Fleet '	<3.2	4.4	27.7	32.7	<3.2	<3.2
00/2350	54.5875	-1.186667	No. 25 Buoy	<3.2	2.8	33.8	38.0	3.5	<3.2
00/2351	54.588167	-1.187667	No. 25 Buoy	36.8	<3.2	10.9	17.7	<3.2	<3.2
00/2353	54.589167	-1.189667	No. 25 Buoy	<3.2	3.9	18.0	13.6	1.2	<3.2
00/2352	54.597333	-1.10068	ICI North Tee	1.1	14.8	24.4	31.8	5.2	<3.2

BDE100	BDE119
12.0	<3.2
24.6	<3.2
83.8	<3.2
41.2	<3.2
62.9	<3.2
<3.2	8.0
30.2	8.4
<3.2	57.5
<3.2	<3.2
9.7	11.0
17.1	3.9
11.1	9.9
<3.2	<3.2
<3.2	4.3
25.6	4.8

BDE209	Sum BDE (ex 209)
182	256
1336	680
7368	1191
802	559
1225	#REF!
678	159
2474	579
2906	510
4737	743
3839	367
2181	313
2324	255
749	168
823	170
4401	403

Annex 7.5. PBDE concentrations in Tees sediment

Lower Tees (Tees Barrage to Tees Mouth) µg/kg <63µm

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71	BDE47	BDE66	BDE77
00/2600	54.565383	-1.285767	R.Tees upstr	0.4	<0.26	<0.26	5.0	0.4	<0.26
00/2340	54.59	-1.143333	Bamlett's Wh	1.9	<0.26	<0.26	16.4	1.9	<0.26
00/2341	54.590667	-1.243333	Bamlett's Big	1.5	<0.26	<0.26	21.2	1.0	<0.26
00/2342	54.5915	-1.242667	Bamlett's Big	2.8	<0.26	1.3	21.3	1.3	<0.26
00/2343	54.5875	-1.236667	Middlesbrou	0.4	<0.26	0.8	3.4	<0.26	<0.26
00/2344	54.588	-1.236	Middlesbrou	1.0	<0.26	1.6	4.4	<0.26	<0.26
00/2345	54.584667	-1.226	Tees Transp	1.4	0.4	8.3	11.1	1.6	<0.26
00/2346	54.585	-1.224167	Tees Transp	2.8	0.6	2.9	<0.26	<0.26	0.1
00/2347	54.581333	-1.2105	Tees Storage	2.3	<0.26	11.3	14.6	2.4	<0.26
00/2348	54.583833	-1.1845	Cargo Fleet \	0.7	<0.26	0.9	5.3	0.9	<0.26
00/2349	54.584667	-1.196167	Cargo Fleet '	1.3	<0.26	6.1	10.1	<0.26	<0.26
00/2350	54.5875	-1.186667	No. 25 Buoy	2.2	<0.26	7.7	0.5	2.3	<0.26
00/2351	54.588167	-1.187667	No. 25 Buoy	1.6	<0.26	<0.26	7.7	<0.26	<0.26
00/2353	54.589167	-1.189667	No. 25 Buoy	1.1	<0.26	3.9	4.3	0.2	<0.26
00/2352	54.597333	-1.10068	ICI North Tee	2.3	0.3	8.2	13.9	2.9	0.1

No.	Latitude	Longitude	Location	BDE99	BDE85	BDE154	BDE153	BDE138	BDE190
00/2600	54.565383	-1.285767	R.Tees upstr	8.5	0.2	0.7	1.1	0.2	<0.26
00/2340	54.59	-1.143333	Bamlett's Wh	21.0	1.1	1.4	2.1	0.4	<0.26
00/2341	54.590667	-1.243333	Bamlett's Big	35.1	1.4	5.0	5.5	0.5	<0.26
00/2342	54.5915	-1.242667	Bamlett's Big	26.1	1.3	7.7	6.8	0.7	<0.26
00/2343	54.5875	-1.236667	Middlesbrou	18.9	0.7	5.8	4.6	0.5	<0.26
00/2344	54.588	-1.236	Middlesbrou	4.1	0.4	1.6	1.3	<0.26	<0.26
00/2345	54.584667	-1.226	Tees Transp	18.5	0.3	<0.26	3.0	0.4	<0.26
00/2346	54.585	-1.224167	Tees Transp	19.9	0.3	6.8	<0.26	<0.26	<0.26
00/2347	54.581333	-1.2105	Tees Storage	19.5	0.3	3.9	4.1	<0.26	<0.26
00/2348	54.583833	-1.1845	Cargo Fleet \	8.9	0.5	0.8	1.1	0.4	<0.26
00/2349	54.584667	-1.196167	Cargo Fleet '	<0.26	0.3	2.1	2.5	<0.26	<0.26
00/2350	54.5875	-1.186667	No. 25 Buoy	<0.26	0.2	2.8	3.1	0.3	<0.26
00/2351	54.588167	-1.187667	No. 25 Buoy	3.3	<0.26	1.0	1.6	<0.26	<0.26
00/2353	54.589167	-1.189667	No. 25 Buoy	<0.26	0.3	1.3	1.0	0.1	<0.26
00/2352	54.597333	-1.10068	ICI North Tee	0.1	1.4	2.3	3.0	0.5	<0.26

BDE100	BDE119
0.8	<0.26
1.7	<0.26
5.4	<0.26
5.5	<0.26
<0.26	<0.26
<0.26	0.8
2.5	0.7
<0.26	4.2
<0.26	<0.26
0.5	0.6
1.3	0.3
0.9	0.8
<0.26	<0.26
<0.26	0.3
2.4	0.5

BDE209	Sum BDE (ex 209)
12.2	17
93.9	48
474.2	77
107.4	75
15.3	35
64.3	15
206.5	48
214.5	38
372.0	58
217.2	21
167.6	24
190.1	21
68.1	15
60.7	12
412.2	38

Annex 7.6. PBDE concentrations in Tees sediment

Tees Estuary (Tees Mouth & Tees Bay)

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71
00/2356	54.604667	-1.163333	ICI No.4 Buoy	1.6	0.15	0.94
00/2357	54.61	-1.155	Shell Oil jetty mid-channel	0.88	0.22	3.8
00/2358	54.6105	-1.159167	Shell Oil jetty north bank	3	0.09	1.4
00/2359	54.612667	-1.143333	Entrance to Dabholm Gut	0.91	<0.05	0.05
00/2360	54.6195	-1.153333	East of No.15 buoy mid channel	1.6	0.15	4.9
00/2361	54.619833	-1.15	East of No.15 buoy south bank	2.6	<0.05	10
00/2332	54.626167	-1.180833	Seal sands	<0.2	<0.2	<0.2
00/2337	54.631167	-1.174167	Seaton-onTees	<0.2	<0.2	<0.2
00/2338	54.631667	-1.155	Off Bran sands mid-channel	3.4	<0.2	0.98
00/2702	54.686317	-1.150067	Tees Bay G6	<0.05	<0.05	<0.05
00/2703	54.69405	-1.1203	Tees Bay G4	0.04	<0.05	0.36
00/2362	54.663333	-1.171667	Tees Bay Off Seaton sands	<0.05	<0.05	<0.05
00/2363	54.656333	-1.163333	Tees Bay Off Seaton sands	<0.05	<0.05	<0.05
00/2704	54.6821	-1.0835	Tees Bay G1	<0.05	<0.05	<0.05
00/2365	54.6485	-1.140833	Tees entrance No.5 Buoy	<0.05	<0.05	0.19
00/2701	54.665267	-1.143217	Tees Bay G5	<0.05	<0.05	<0.05
00/2700	54.6568	-1.114	Tees Bay G3	<0.05	<0.05	<0.05
00/2705	54.6616	-1.083483	Tees Bay G2	<0.05	<0.05	0.05
00/2713	54.680367	-1.049783	Tees Bay Inshore disposal site C4	0.42	0.01	0.16
00/2367	54.636333	-1.110667	Off Coatham sands	<0.05	<0.05	<0.05
00/2368	54.629167	-1.093	Off Coatham sands	<0.05	<0.05	<0.05
00/2706	54.673567	-1.027317	Tees Inshore disposal site C6	<0.05	<0.05	<0.05
00/2757	54.733183	-1.88305	NMMP 295 Off Tee's	<0.05	<0.05	<0.05

No.	Latitude	Longitude	Location	BDE99	BDE85	BDE154
00/2356	54.604667	-1.163333	ICI No.4 Buoy	21	1.3	1.7
00/2357	54.61	-1.155	Shell Oil jetty mid-channel	15	0.84	0.08
00/2358	54.6105	-1.159167	Shell Oil jetty north bank	29	1.64	3.6
00/2359	54.612667	-1.143333	Entrance to Dabholm Gut	17	0.96	1.1
00/2360	54.6195	-1.153333	East of No.15 buoy mid channel	21	1.2	1.4
00/2361	54.619833	-1.15	East of No.15 buoy south bank	36	2.1	2.2
00/2332	54.626167	-1.180833	Seal sands	<0.2	<0.2	<0.2
00/2337	54.631167	-1.174167	Seaton-onTees	3.6	<0.2	0.4
00/2338	54.631667	-1.155	Off Bran sands mid-channel	38	1.6	3.7
00/2702	54.686317	-1.150067	Tees Bay G6	0.19	<0.05	0.05
00/2703	54.69405	-1.1203	Tees Bay G4	2.8	0.12	0.27
00/2362	54.663333	-1.171667	Tees Bay Off Seaton sands	<0.05	<0.05	<0.05
00/2363	54.656333	-1.163333	Tees Bay Off Seaton sands	<0.05	<0.05	<0.05
00/2704	54.6821	-1.0835	Tees Bay G1	0.19	<0.05	0.06
00/2365	54.6485	-1.140833	R. Tees entrance No. 5 Buoy	1.2	<0.05	0.12
00/2701	54.665267	-1.143217	Tees Bay G5	0.11	<0.05	0.05
00/2700	54.6568	-1.114	Tees Bay G3	0.13	<0.05	0.05
00/2705	54.6616	-1.083483	Tees Bay G2	0.46	<0.05	0.08

00/2713	54.680367	-1.049783	Tees Bay Inshore disposal site C4	0.16	0.43	0.56
00/2367	54.636333	-1.110667	Off Coatham sands	0.13	<0.05	<0.05
00/2368	54.629167	-1.093	Off Coatham sands	0.18	<0.05	0.05
00/2706	54.673567	-1.027317	Tees Inshore disposal site C6	1.2	0.08	0.14
00/2757	54.733183	-1.88305	NMMP 295 Off Tee's	0.63	<0.05	<0.05

BDE47	BDE66	BDE77	BDE100	BDE119
12	2.5	<0.05	2.1	0.19
8.5	1.6	0.1	1.5	0.45
18	3.6	<0.05	3.2	2
11	0.08	<0.05	2.4	0.17
0.06	2.7	0.16	1.8	0.64
18	4.2	<0.05	2.8	2
<0.2	<0.2	<0.2	<0.2	<0.2
1.8	0.2	<0.2	0.36	<0.2
32.2	2.8	<0.2	4.5	<0.2
0.15	<0.05	<0.05	<0.05	<0.05
1.6	<0.05	<0.05	0.4	<0.05
0.3	<0.05	<0.05	0.06	<0.05
0.36	<0.05	<0.05	<0.05	<0.05
0.23	<0.05	<0.05	0.06	0.03
0.85	0.14	<0.05	0.15	0.03
0.12	<0.05	<0.05	0.05	<0.05
0.12	<0.05	<0.05	0.06	<0.05
0.37	<0.05	<0.05	0.09	0.04
3.6	0.67	<0.05	0.64	0.14
0.14	<0.05	<0.05	<0.05	<0.05
0.19	0.06	<0.05	0.06	0.04
1.1	0.15	<0.05	0.17	0.05
0.54	<0.05	<0.05	<0.05	<0.05

BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
0.06	0.37	<0.05	236	44
1.6	0.29	0.11	209	35
0.08	0.58	<0.05	246	66
0.77	0.13	<0.05	1400	35
2.3	<0.05	<0.05	281	38
4.2	<0.05	<0.05	812	84
<0.2	<0.2	<0.2	<0.2	<0.2
0.4	<0.2	<0.2	10.2	7
4.6	0.5	<0.2	117	92
0.07	<0.05	<0.05	2.8	<0.05
0.28	<0.05	<0.05	5	6
<0.05	<0.05	<0.05	<0.05	<0.05
<0.05	<0.05	<0.05	<0.05	<0.05
0.07	<0.05	<0.05	<0.05	1
0.17	0.08	<0.05	9.6	3
0.06	<0.05	<0.05	<0.05	<0.05
<0.05	<0.05	<0.05	<0.05	<0.05
0.1	<0.05	<0.05	3.7	1

1	0.18	<0.05	17	8
<0.05	<0.05	<0.05	<0.05	<0.05
0.06	<0.05	<0.05	<0.05	1
0.17	<0.05	<0.05	17	3
<0.05	<0.05	<0.05	<0.5	1

Annex 7.7. PBDE concentrations in Tees sediment

Tees Estuary (Tees Mouth & Tees Bay)

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71
00/2356	54.604667	-1.163333	ICI No.4 Buoy	#REF!	#REF!	#REF!
00/2357	54.61	-1.155	Shell Oil jetty mid-channel	#REF!	#REF!	#REF!
00/2358	54.6105	-1.159167	Shell Oil jetty north bank	#REF!	#REF!	#REF!
00/2359	54.612667	-1.143333	Entrance to Dabholm Gut	#REF!	<4.7	#REF!
00/2360	54.6195	-1.153333	East of No.15 buoy mid channel	#REF!	#REF!	#REF!
00/2361	54.619833	-1.15	East of No.15 buoy south bank	#REF!	<4.7	#REF!
00/2332	54.626167	-1.180833	Seal sands	<4.7	<4.7	<4.7
00/2337	54.631167	-1.174167	Seaton-onTees	<4.7	<4.7	<4.7
00/2338	54.631667	-1.155	Off Bran sands mid-channel	#REF!	<4.7	#REF!
00/2702	54.686317	-1.150067	Tees Bay G6	<4.7	<4.7	<4.7
00/2703	54.69405	-1.1203	Tees Bay G4	#REF!	<4.7	#REF!
00/2362	54.663333	-1.171667	Tees Bay Off Seaton sands	NA	NA	NA
00/2363	54.656333	-1.163333	Tees Bay Off Seaton sands	NA	NA	NA
00/2704	54.6821	-1.0835	Tees Bay G1	<4.7	<4.7	<4.7
00/2365	54.6485	-1.140833	Tees entrance No.5 Buoy	<4.7	<4.7	#REF!
00/2701	54.665267	-1.143217	Tees Bay G5	<4.7	<4.7	<4.7
00/2700	54.6568	-1.114	Tees Bay G3	<4.7	<4.7	<4.7
00/2705	54.6616	-1.083483	Tees Bay G2	<4.7	<4.7	#REF!
00/2713	54.680367	-1.049783	Tees Bay Inshore disposal site C4			
00/2367	54.636333	-1.110667	Off Coatham sands			
00/2368	54.629167	-1.093	Off Coatham sands			
00/2706	54.673567	-1.027317	Tees Inshore disposal site C6			
00/2757	54.733183	-1.88305	NMMP 295 Off Tee's			

No.	Latitude	Longitude	Location	BDE99	BDE85	BDE154
00/2356	54.604667	-1.163333	ICI No.4 Buoy	#REF!	#REF!	#REF!
00/2357	54.61	-1.155	Shell Oil jetty mid-channel	#REF!	#REF!	#REF!
00/2358	54.6105	-1.159167	Shell Oil jetty north bank	#REF!	#REF!	#REF!
00/2359	54.612667	-1.143333	Entrance to Dabholm Gut	#REF!	#REF!	#REF!
00/2360	54.6195	-1.153333	East of No.15 buoy mid channel	#REF!	#REF!	#REF!
00/2361	54.619833	-1.15	East of No.15 buoy south bank	#REF!	#REF!	#REF!
00/2332	54.626167	-1.180833	Seal sands	<4.7	<4.7	<4.7
00/2337	54.631167	-1.174167	Seaton-onTees	#REF!	<4.7	#REF!
00/2338	54.631667	-1.155	Off Bran sands mid-channel	#REF!	#REF!	#REF!
00/2702	54.686317	-1.150067	Tees Bay G6	#REF!	<4.7	#REF!
00/2703	54.69405	-1.1203	Tees Bay G4	#REF!	#REF!	#REF!
00/2362	54.663333	-1.171667	Tees Bay Off Seaton sands	NA	NA	NA
00/2363	54.656333	-1.163333	Tees Bay Off Seaton sands	NA	NA	NA
00/2704	54.6821	-1.0835	Tees Bay G1	#REF!	<4.7	#REF!
00/2365	54.6485	-1.140833	R. Tees entrance No. 5 Buoy	#REF!	<4.7	#REF!
00/2701	54.665267	-1.143217	Tees Bay G5	#REF!	<4.7	#REF!
00/2700	54.6568	-1.114	Tees Bay G3	#REF!	<4.7	#REF!
00/2705	54.6616	-1.083483	Tees Bay G2	#REF!	<4.7	#REF!

00/2713	54.680367	-1.049783	Tees Bay Inshore disposal site C4
00/2367	54.636333	-1.110667	Off Coatham sands
00/2368	54.629167	-1.093	Off Coatham sands
00/2706	54.673567	-1.027317	Tees Inshore disposal site C6
00/2757	54.733183	-1.88305	NMMP 295 Off Tee's

BDE47	BDE66	BDE77	BDE100	BDE119
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
<4.7	<4.7	<4.7	<4.7	<4.7
#REF!	#REF!	<4.7	#REF!	<4.7
#REF!	#REF!	<4.7	#REF!	<4.7
#REF!	<4.7	<4.7	<4.7	<4.7
#REF!	<4.7	<4.7	#REF!	<4.7
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
#REF!	<4.7	<4.7	#REF!	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	<4.7	<4.7	#REF!	<4.7
#REF!	<4.7	<4.7	#REF!	<4.7
#REF!	<4.7	<4.7	#REF!	#REF!

BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	<4.7	<4.7	#REF!	#REF!
#REF!	<4.7	<4.7	#REF!	#REF!
<4.7	<4.7	<4.7	<4.7	<4.7
#REF!	<4.7	<4.7	#REF!	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	<4.7	<4.7	#REF!	#REF!
#REF!	<4.7	<4.7	#REF!	#REF!
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
#REF!	<4.7	<4.7	<4.7	#REF!
#REF!	#REF!	<4.7	#REF!	#REF!
#REF!	<4.7	<4.7	<4.7	#REF!
#VALUE!	<4.7	<4.7	<4.7	<4.7
#REF!	<4.7	<4.7	#REF!	#REF!

Annex 7.8. PBDE concentrations in Tees sediment

Tees Estuary (Tees Mouth & Tees Bay)

No.	Latitude	Longitude	Location	BDE28	BDE75	BDE71
00/2356	54.604667	-1.163333	ICI No.4 Buoy	#REF!	#REF!	#REF!
00/2357	54.61	-1.155	Shell Oil jetty mid-channel	#REF!	#REF!	#REF!
00/2358	54.6105	-1.159167	Shell Oil jetty north bank	#REF!	#REF!	#REF!
00/2359	54.612667	-1.143333	Entrance to Dabholm Gut	#REF!	<0.43	#REF!
00/2360	54.6195	-1.153333	East of No.15 buoy mid channel	#REF!	#REF!	#REF!
00/2361	54.619833	-1.15	East of No.15 buoy south bank	#REF!	<0.43	#REF!
00/2332	54.626167	-1.180833	Seal sands	<0.43	<0.43	<0.43
00/2337	54.631167	-1.174167	Seaton-onTees	<0.43	<0.43	<0.43
00/2338	54.631667	-1.155	Off Bran sands mid-channel	#REF!	<0.43	#REF!
00/2702	54.686317	-1.150067	Tees Bay G6	<0.43	<0.43	<0.43
00/2703	54.69405	-1.1203	Tees Bay G4	#REF!	<0.43	#REF!
00/2362	54.663333	-1.171667	Tees Bay Off Seaton sands	NA	NA	NA
00/2363	54.656333	-1.163333	Tees Bay Off Seaton sands	NA	NA	NA
00/2704	54.6821	-1.0835	Tees Bay G1	<0.43	<0.43	<0.43
00/2365	54.6485	-1.140833	Tees entrance No.5 Buoy	<0.43	<0.43	#REF!
00/2701	54.665267	-1.143217	Tees Bay G5	<0.43	<0.43	<0.43
00/2700	54.6568	-1.114	Tees Bay G3	<0.43	<0.43	<0.43
00/2705	54.6616	-1.083483	Tees Bay G2	<0.43	<0.43	#REF!
00/2713	54.680367	-1.049783	Tees Bay Inshore disposal site C4	NA	NA	NA
00/2367	54.636333	-1.110667	Off Coatham sands	NA	NA	NA
00/2368	54.629167	-1.093	Off Coatham sands	NA	NA	NA
00/2706	54.673567	-1.027317	Tees Inshore disposal site C6	NA	NA	NA
00/2757	54.733183	-1.88305	NMMP 295 Off Tee's	NA	NA	NA

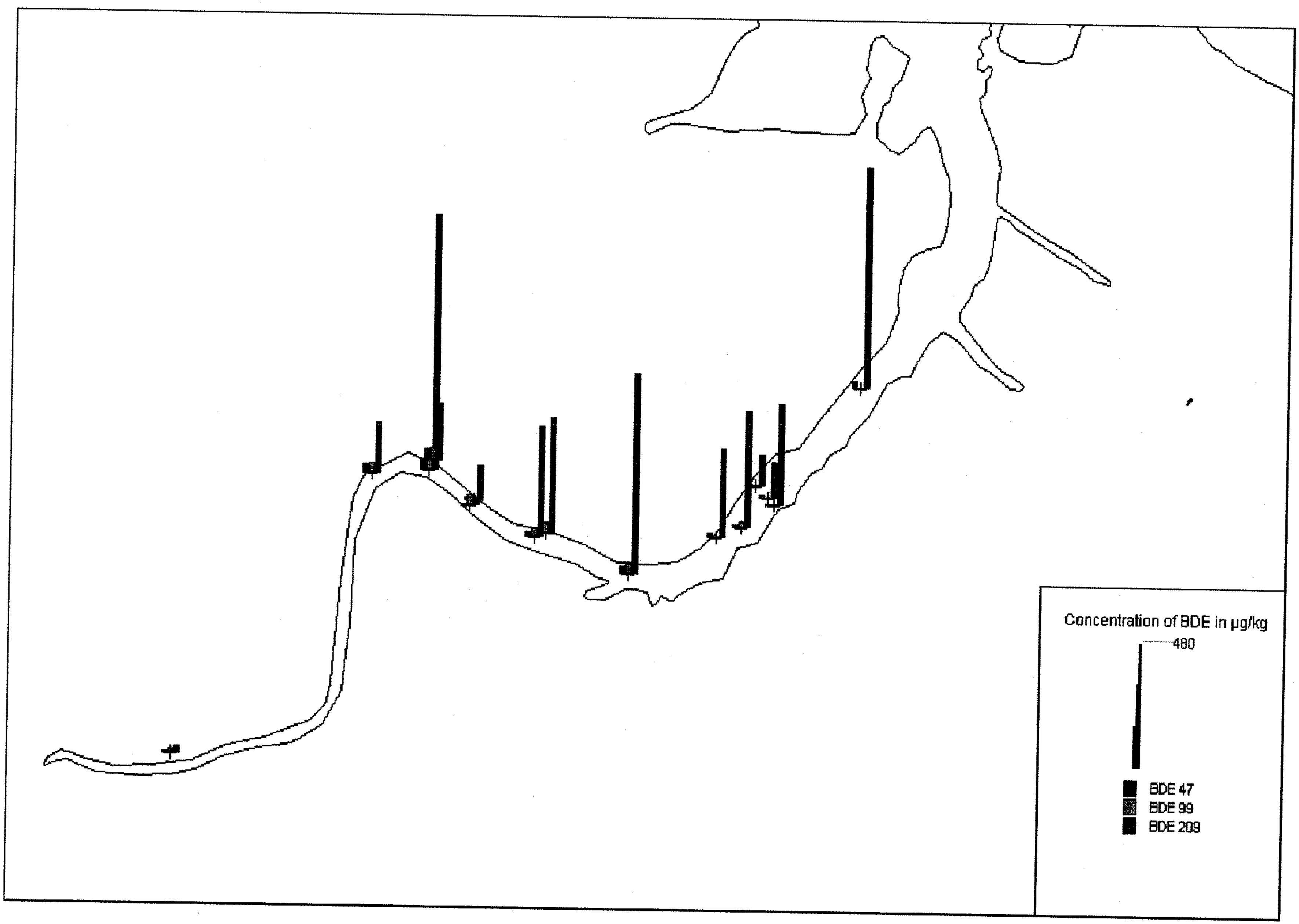
				BDE99	BDE85	BDE154
00/2356	54.604667	-1.163333	ICI No.4 Buoy	#REF!	#REF!	#REF!
00/2357	54.61	-1.155	Shell Oil jetty mid-channel	#REF!	#REF!	#REF!
00/2358	54.6105	-1.159167	Shell Oil jetty north bank	#REF!	#REF!	#REF!
00/2359	54.612667	-1.143333	Entrance to Dabholm Gut	#REF!	#REF!	#REF!
00/2360	54.6195	-1.153333	East of No.15 buoy mid channel	#REF!	#REF!	#REF!
00/2361	54.619833	-1.15	East of No.15 buoy south bank	#REF!	#REF!	#REF!
00/2332	54.626167	-1.180833	Seal sands	<0.43	<0.43	<0.43
00/2337	54.631167	-1.174167	Seaton-onTees	#REF!	<0.43	#REF!
00/2338	54.631667	-1.155	Off Bran sands mid-channel	#REF!	#REF!	#REF!
00/2702	54.686317	-1.150067	Tees Bay G6	#REF!	<0.43	#REF!
00/2703	54.69405	-1.1203	Tees Bay G4	#REF!	#REF!	#REF!
00/2362	54.663333	-1.171667	Tees Bay Off Seaton sands	NA	NA	NA
00/2363	54.656333	-1.163333	Tees Bay Off Seaton sands	NA	NA	NA
00/2704	54.6821	-1.0835	Tees Bay G1	#REF!	<0.43	#REF!
00/2365	54.6485	-1.140833	R. Tees entrance No. 5 Buoy	#REF!	<0.43	#REF!
00/2701	54.665267	-1.143217	Tees Bay G5	#REF!	<0.43	#REF!
00/2700	54.6568	-1.114	Tees Bay G3	#REF!	<0.43	#REF!
00/2705	54.6616	-1.083483	Tees Bay G2	#REF!	<0.43	#REF!

00/2713	54.680367	-1.049783	Tees Bay Inshore disposal site C4	NA	NA	NA
00/2367	54.636333	-1.110667	Off Coatham sands	NA	NA	NA
00/2368	54.629167	-1.093	Off Coatham sands	NA	NA	NA
00/2706	54.673567	-1.027317	Tees Inshore disposal site C6	NA	NA	NA
00/2757	54.733183	-1.88305	NMMP 295 Off Tee's	NA	NA	NA

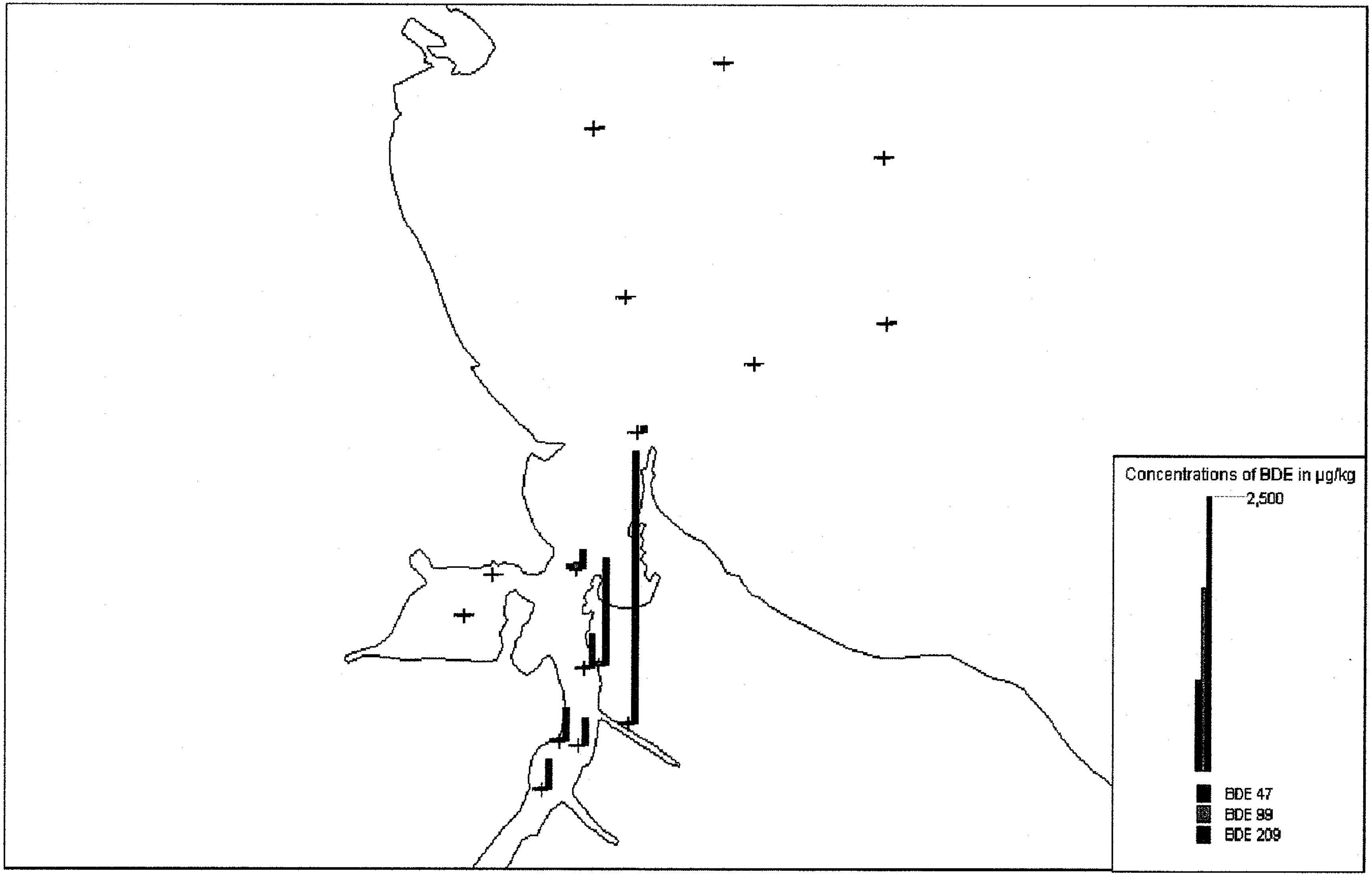
BDE47	BDE66	BDE77	BDE100	BDE119
#REF!	#REF!	<0.43	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	<0.43	#REF!	#REF!
#REF!	#REF!	<0.43	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	<0.43	#REF!	#REF!
<0.43	<0.43	<0.43	<0.43	<0.43
#REF!	#REF!	<0.43	#REF!	<0.43
#REF!	#REF!	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	<0.43	<0.43
#REF!	<0.43	<0.43	#REF!	<0.43
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
#REF!	<0.43	<0.43	#REF!	#REF!
#REF!	#REF!	<0.43	#REF!	#REF!
#REF!	<0.43	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	#REF!	#REF!
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA

BDE153	BDE138	BDE190	BDE209	Sum BDE (ex 209)
#REF!	#REF!	<0.43	#REF!	<0.43
#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	<0.43	#REF!	<0.43
#REF!	#REF!	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	#REF!	<0.43
<0.43	<0.43	<0.43	<0.43	<4.7
#REF!	<0.43	<0.43	#REF!	<0.43
#REF!	#REF!	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	#REF!	<0.43
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
#REF!	<0.43	<0.43	<0.43	<0.43
#REF!	<0.43	<0.43	#REF!	<0.43
#REF!	<0.43	<0.43	<0.43	<0.43
<0.43	<0.43	<0.43	<0.43	<4.7
#REF!	<0.43	<0.43	#REF!	<0.43

NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA



Lower Tees. BDE levels in sediments.

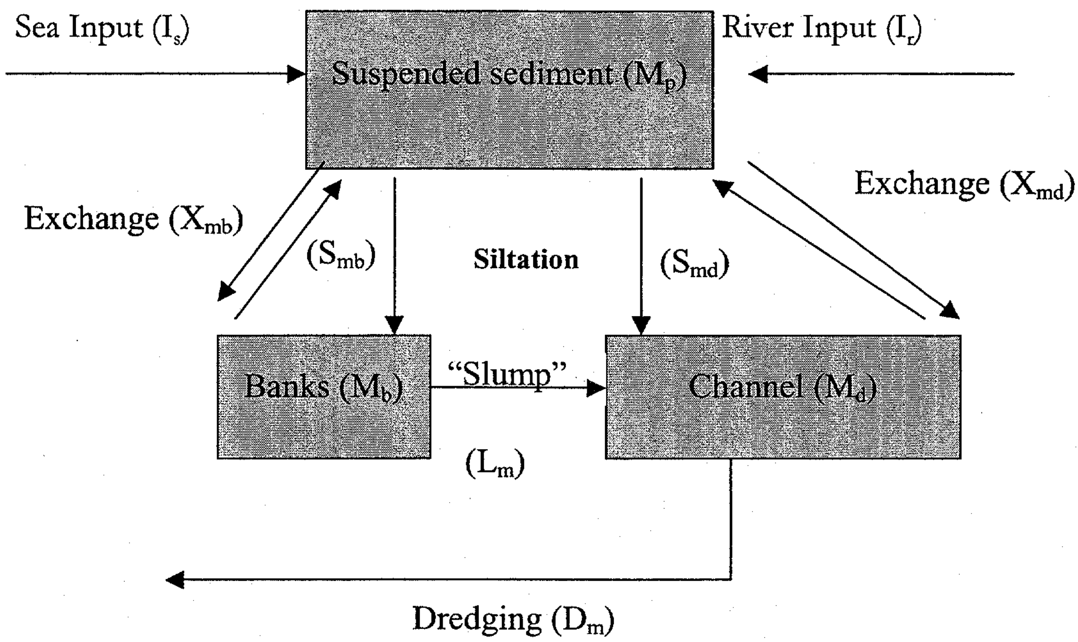


Tees Estuary (Tees Mouth and Tees Bay). BDE levels in sediments.

Annex 8. Modelling data (WP 3)

Conceptual model structure

Sediments



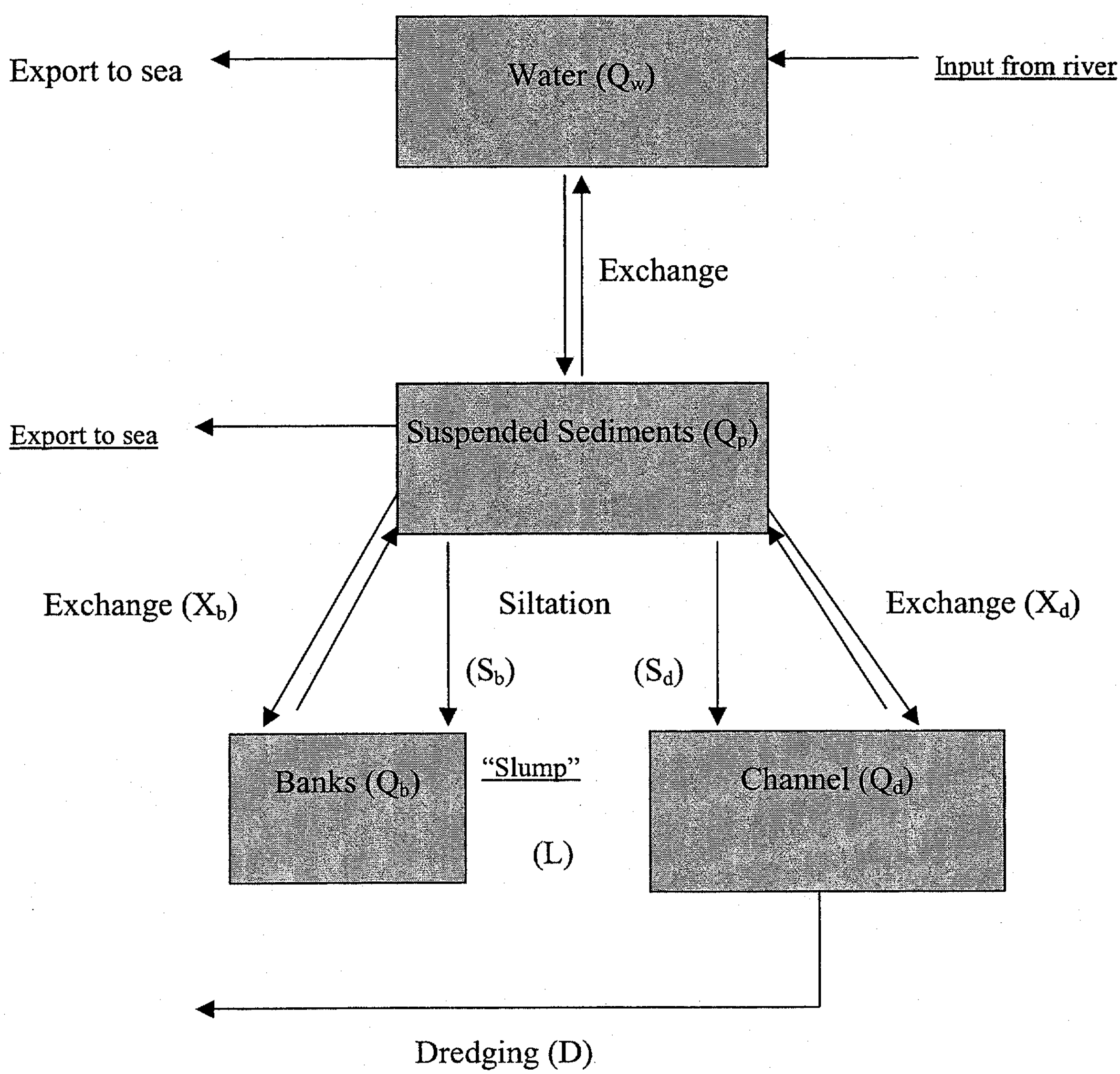
$S_m = I_s + I_R$

$X_{mb} = X_{md} = 0$

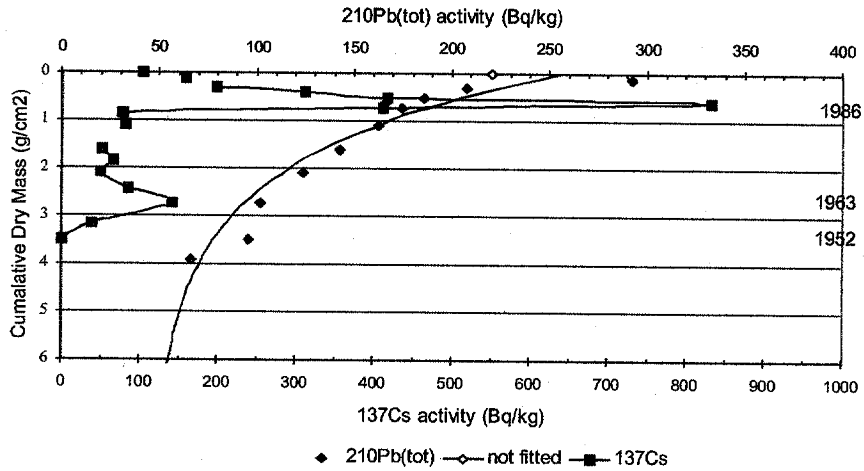
$D_m = S_{mb} + S_{md}$

$L_m \sim S_{mb}$

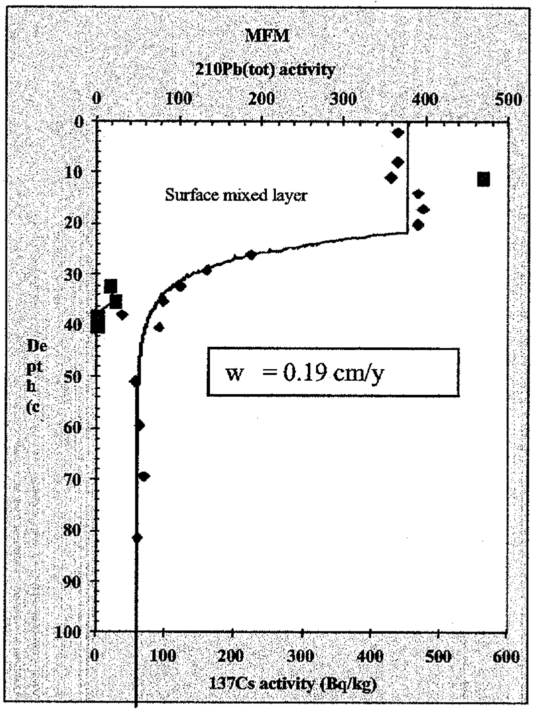
Contaminants



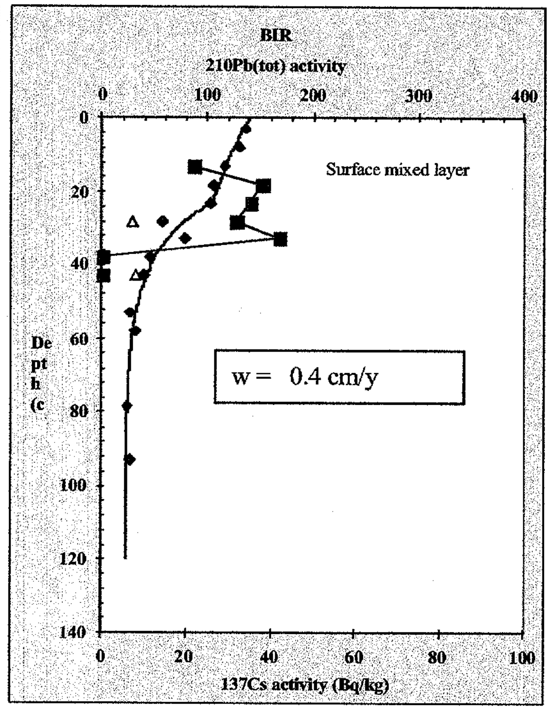
Annex 9. Sediment core dating profiles (WP 4)



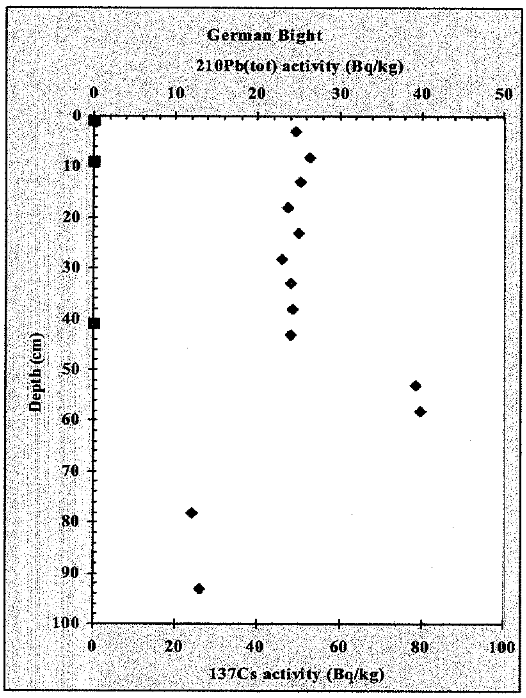
Drammenfjord (Oslofjord, Norway)



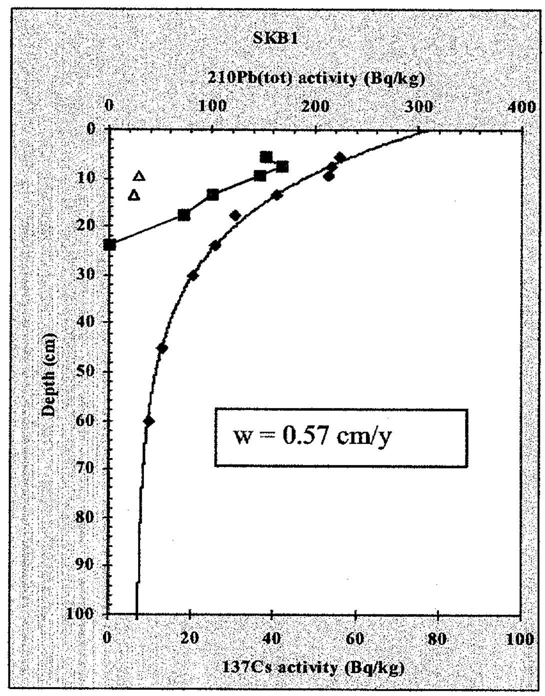
Meerfelder Maar (Eifel, Germany)



Birkat Ram, Israel



German Bight (North Sea, Germany)



Skagerak (North Sea, Denmark)

Annex 9.2. PBDE s and PBBs in sediment cores (ug/kg wet weight)
German Bight Helgoland
(500 mm/100 years)

lims	*2000/1988*	*2000/1989*	*2000/1990*	*2000/1991*	*2000/1992*	*2000/1993*
	DBH-1	DBH-2	DBH-4	DBH-6	DBH-8	DBH-10
depth	*0-2 cm*	*2-4 cm*	*6-8 cm*	*10-12 cm*	*14-16 cm*	*40-42 cm*
BDE 28	<0.1	<0.09	<0.1	<0.07	<0.1	<0.09
BDE 47	<0.1	<0.1	<0.1	<0.08	<0.1	<0.1
BDE 66	<0.1	<0.09	<0.1	<0.07	<0.1	<0.09
BDE 71	<0.1	<0.09	<0.1	<0.07	<0.1	<0.09
BDE 75	<0.1	<0.09	<0.1	<0.07	<0.1	<0.09
BDE 77	<0.1	<0.09	<0.1	<0.08	<0.1	<0.1
BDE 85	<0.04	<0.03	<0.04	<0.03	<0.04	<0.03
BDE 99	<0.1	<0.09	<0.1	<0.08	<0.1	<0.1
BDE 100	<0.1	<0.09	<0.1	<0.08	<0.1	<0.1
BDE 119	<0.1	<0.09	<0.1	<0.07	<0.1	<0.09
BDE 138	<0.1	<0.09	<0.1	<0.07	<0.1	<0.09
BDE 153	<0.1	<0.09	<0.1	<0.08	<0.1	<0.1
BB 153+BDE 154	<0.3	<0.2	<0.3	<0.2	<0.3	<0.2
BDE 190	<0.1	<0.09	<0.1	<0.07	<0.1	<0.09
BDE 209	<0.5	<0.4	<0.5	<0.3	<0.5	<0.4
HBCD	<1	<0.9	<1	<0.8	<1	<1

PBDE s and PBBs in sediment cores (ug/kg dry weight)
German Bight Helgoland
(500 mm/100 years)

lims	*2000/1988*	*2000/1989*	*2000/1990*	*2000/1991*	*2000/1992*	*2000/1993*
	DBH-1	DBH-2	DBH-4	DBH-6	DBH-8	DBH-10
depth	*0-2 cm*	*2-4 cm*	*6-8 cm*	*10-12 cm*	*14-16 cm*	*40-42 cm*
BDE 28	<0.1	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 47	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2
BDE 66	<0.2	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 71	<0.1	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 75	<0.2	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 77	<0.2	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 85	<0.06	<0.05	<0.08	<0.04	<0.08	<0.05
BDE 99	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2
BDE 100	<0.2	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 119	<0.1	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 138	<0.1	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 153	<0.2	<0.1	<0.2	<0.1	<0.2	<0.1
BB 153+BDE 154	<0.4	<0.4	<0.5	<0.3	<0.5	<0.3
BDE 190	<0.2	<0.1	<0.2	<0.1	<0.2	<0.1
BDE 209	<0.7	<0.6	<0.9	<0.5	<0.9	<0.6
HBCD	<2	<2	<2	<1	<2	<1

Annex 9.3. PBDE s and PBBs in sediment cores (ug/kg wet weight)

Skagerak

(600 mm/100 years)

lims	2000/1994	2000/1995	2000/1996	2000/1997	2000/1998	2000/1999
	SKA-1	SKA-2	SKA-4	SKA-6	SKA-7	SKA-9
depth	*1-3 cm*	*3-5 cm*	*8-10 cm*	*16-18 cm*	*22-24 cm*	*40-42 cm*
BDE 28	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 47	0.29	0.25	0.20	<0.1	0.09	0.07
BDE 66	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 71	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 75	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 77	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BDE 85	<0.04	0.05	<0.03	<0.04	0.06	<0.05
BDE 99	0.15	0.15	0.11	<0.1	<0.1	<0.1
BDE 100	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 119	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 138	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 153	0.25	0.27	<0.1	<0.1	<0.1	<0.1
BB 153+BDE 154	<0.3	<0.3	<0.2	<0.3	<0.3	<0.3
BDE 190	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 209	0.61	<0.6	<0.4	<0.5	<0.5	<0.6
HBCD	<1	<1	<1	<1	<1	<1

PBDE s and PBBs in sediment cores (ug/kg dry weight)

Skagerak

(600 mm/100 years)

lims	2000/1994	2000/1995	2000/1996	2000/1997	2000/1998	2000/1999
	SKA-1	SKA-2	SKA-4	SKA-6	SKA-7	SKA-9
depth	*1-3 cm*	*3-5 cm*	*8-10 cm*	*16-18 cm*	*22-24 cm*	*40-42 cm*
[redacted]						
BDE 28	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 47	0.62	0.52	0.43	<0.3	0.18	0.12
BDE 66	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 71	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 75	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 77	<0.2	<0.3	<0.2	<0.3	<0.2	<0.2
BDE 85	<0.09	0.10	<0.07	<0.09	0.12	<0.09
BDE 99	0.31	0.30	0.24	<0.3	<0.2	<0.3
BDE 100	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 119	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 138	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 153	0.52	0.56	<0.2	<0.3	<0.2	<0.2
BB 153+BDE 154	<0.6	<0.7	<0.5	<0.6	<0.6	<0.6
BDE 190	<0.2	<0.3	<0.2	<0.2	<0.2	<0.2
BDE 209	1.3	<1	<0.9	<1	<1	<1
HBCD	<3	<3	<2	<3	<2	<3

Annex 9.4. PBDE s and PBBs in sediment cores (ug/kg wet weight)
Birkat Ram

lims nr	*2001/216*	*2001/217*	*2001/218*	*2001/219*	*2001/220*	*2001/221*
	BIR2-1/1	BIR2-1/3	BIR2-1/5	BIR2-1/7	BIR2-1/9	BIR2-1/19
depth (cm)	*1.5-4.5*	*11.5-14.5*	*21.5-24.5*	*31.5-34.5*	*41.5-44.5*	*91.5-94.5*
BDE 28	<0.05	<0.05	<0.04	<0.04	<0.05	<0.05
BDE 47	<0.06	<0.05	<0.05	<0.05	<0.05	<0.06
BDE 66	<0.05	<0.05	<0.04	<0.05	<0.05	<0.05
BDE 71	<0.05	<0.05	<0.04	<0.04	<0.05	<0.05
BDE 75	<0.05	<0.05	<0.04	<0.05	<0.05	<0.05
BDE 77	<0.05	<0.05	<0.04	<0.05	<0.05	<0.05
BDE 85	<0.04	<0.04	<0.03	<0.04	<0.04	<0.04
BDE 99	<0.06	<0.05	<0.05	<0.05	<0.05	<0.05
BDE 100	<0.05	<0.05	<0.04	<0.05	<0.05	<0.05
BDE 119	<0.05	<0.05	<0.04	<0.04	<0.05	<0.05
BDE 138	<0.05	<0.05	<0.04	<0.04	<0.05	<0.05
BDE 153	<0.07	<0.07	<0.06	<0.07	<0.07	<0.07
BB 153+BDE 154	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BDE 190	<0.1	<0.1	<0.09	<0.1	<0.1	<0.1
BDE 209	7.9	2.3	3.3	<0.2	<0.2	<0.2
HBCD	1.7	<0.22	1.3	<0.2	<0.2	1.7

PBDEs and PBBs in sediment cores (ug/kg dry weight)
Birkat Ram

lims nr	*2001/216*	*2001/217*	*2001/218*	*2001/219*	*2001/220*	*2001/221*
	BIR2-1/1	BIR2-1/3	BIR2-1/5	BIR2-1/7	BIR2-1/9	BIR2-1/19
depth (cm)	*1.5-4.5*	*11.5-14.5*	*21.5-24.5*	*31.5-34.5*	*41.5-44.5*	*91.5-94.5*
[redacted]						
BDE 28	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2
BDE 47	<0.2	<0.2	<0.1	<0.2	<0.3	<0.2
BDE 66	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2
BDE 71	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2
BDE 75	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2
BDE 77	<0.2	<0.2	<0.1	<0.2	<0.3	<0.2
BDE 85	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1
BDE 99	<0.2	<0.2	<0.1	<0.2	<0.3	<0.2
BDE 100	<0.2	<0.2	<0.1	<0.2	<0.2	<0.2
BDE 119	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2
BDE 138	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2
BDE 153	<0.2	<0.2	<0.2	<0.2	<0.4	<0.3
BB 153+BDE 154	<0.4	<0.4	<0.3	<0.4	<0.6	<0.4
BDE 190	<0.3	<0.3	<0.3	<0.3	<0.5	<0.4
BDE 209	25	7.3	10	<0.6	<1	<0.7
HBCD	5.4	<0.7	3.9	<0.7	<1	6.1

Annex 9.5. PBDE s and PBBs in sediment cores (ug/kg wet weight)

Meerfelder Maar, Eifel

	ug/kg dry weight					
lims nr	*2001/210*	*2001/211*	*2001/212*	*2001/213*	*2001/214*	*2001/215*
	MFM6-1/2	MFM6-1/3	MFM6-1/5	MFM6-1/7	MFM6-1/10	MFM6-1/15
depth (cm)	*3.5-6.5*	*6.5-9.5*	*12.5-15.5*	*18.5-21.5*	*27.5-30.5*	*41.2-45.3*
BDE 28	<0.04	<0.04	<0.04	<0.05	<0.05	<0.04
BDE 47	<0.05	<0.05	<0.05	<0.06	<0.06	<0.05
BDE 66	<0.04	<0.04	<0.04	<0.05	<0.05	<0.04
BDE 71	<0.04	<0.04	<0.04	<0.05	<0.05	<0.04
BDE 75	<0.04	<0.04	<0.04	<0.05	<0.05	<0.04
BDE 77	<0.04	<0.04	<0.05	<0.05	<0.05	<0.04
BDE 85	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
BDE 99	<0.05	<0.05	0.41	<0.06	<0.05	<0.05
BDE 100	<0.04	<0.04	0.10	<0.05	<0.05	<0.04
BDE 119	<0.04	<0.04	<0.04	<0.05	<0.05	<0.04
BDE 138	<0.04	<0.04	<0.04	<0.05	<0.05	<0.04
BDE 153	<0.06	<0.06	0.12	<0.08	<0.07	0.10
BB 153+BDE 154	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BDE 190	<0.09	<0.09	<0.09	<0.1	<0.1	<0.09
BDE 209	<0.2	15	2.3	<0.2	<0.2	21
HBCD	1.4	1.4	3.6	<0.2	0.54	0.44

PBDEs and PBBs in sediment cores (ug/kg dry weight)

Meerfelder Maar, Eifel

	ug/kg dry weight					
lims nr	*2001/210*	*2001/211*	*2001/212*	*2001/213*	*2001/214*	*2001/215*
	MFM6-1/2	MFM6-1/3	MFM6-1/5	MFM6-1/7	MFM6-1/10	MFM6-1/15
depth (cm)	*3.5-6.5*	*6.5-9.5*	*12.5-15.5*	*18.5-21.5*	*27.5-30.5*	*41.2-45.3*
BDE 28	<0.4	<0.5	<0.6	<1	<0.6	<0.1
BDE 47	<0.5	<0.6	<0.7	<1	<0.7	<0.1
BDE 66	<0.5	<0.5	<0.6	<1	<0.6	<0.1
BDE 71	<0.4	<0.5	<0.6	<1	<0.6	<0.1
BDE 75	<0.5	<0.5	<0.6	<1	<0.6	<0.1
BDE 77	<0.5	<0.5	<0.6	<1	<0.7	<0.1
BDE 85	<0.4	<0.4	<0.5	<0.8	<0.5	<0.1
BDE 99	<0.5	<0.5	5.5	<1	<0.7	<0.1
BDE 100	<0.5	<0.5	1.3	<1	<0.7	<0.1
BDE 119	<0.4	<0.5	<0.6	<1	<0.6	<0.1
BDE 138	<0.4	<0.5	<0.6	<1	<0.6	<0.1
BDE 153	<0.7	<0.7	1.6	<1	<0.9	0.29
BB 153+BDE 154	<1	<1	<1	<2	<2	<0.3
BDE 190	<1	<1	<1	<2	<1	<0.3
BDE 209	<2	172	31	<4	<3	59
HBCD	15	16	48	<5	7.1	1.2

ANNEX 9.7 BDE concentrations in sediment cores on an organic carbon basis.

9.7.1. Western Wadden Sea (The Netherlands)

Amount BDE in ng per g organic carbon

	1994±2	1985±3	1975±3	1963±4	1943±4	1933±4
BDE28	< 2	25	23	< 1	< 2	< 1
BDE75	< 2	< 3	< 1	< 1	< 2	< 1
BDE71	< 1	< 2	< 1	< 1	< 2	< 1
BDE47	13	19	14	7	9	< 1
BDE66	< 2	< 3	< 1	< 1	< 2	< 1
BDE77	< 2	< 3	< 1	< 1	< 2	< 1
BDE100	< 2	< 3	< 1	< 1	< 2	< 1
BDE119	< 2	< 3	< 1	< 1	< 2	< 1
BDE99	14	21	16	7	< 2	< 1
BDE85	< 2	< 3	< 1	< 1	< 2	< 1
BDE154	< 2	< 3	< 1	< 1	< 2	< 1
BDE153	< 2	< 3	< 1	< 1	< 2	< 1
BDE138	< 1	< 2	< 1	< 1	< 2	< 1
BDE190	< 2	< 3	< 2	< 1	< 3	< 1
BDE209	250	380	229	< 1	< 3	< 1
%C	*0.392*	*0.238*	*0.493*	*0.829*	*0.325*	*0.488*

9.7.2. Lake Woserin (Germany)

Amount BDE in ng per g organic carbon

	1997±1	1994±1	1991±1	1985±1	1979±2	1973±2	1628±10
BDE28	0.93	1.14	1.53	1.98	1.45	0.65	< 0.2
BDE75	< 0.3	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.2
BDE71	< 0.3	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.2
BDE47	4.97	5.78	5.60	6.73	7.58	2.16	< 0.2
BDE66	0.93	1.11	1.44	1.24	< 0.3	< 0.3	< 0.2
BDE77	< 0.3	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.2
BDE100	1.52	1.57	1.70	2.05	2.30	1.29	< 0.2
BDE119	< 0.3	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.2
BDE99	8.99	11.26	11.58	9.44	7.16	3.17	2.58
BDE85	< 0.3	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.2
BDE154	< 0.3	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.2
BDE153	1.45	1.70	1.57	1.39	< 0.3	< 0.3	< 0.2
BDE138	< 0.3	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.2
BDE190	< 0.4	< 0.3	< 0.2	< 0.2	< 0.4	< 0.4	< 0.3
BDE209	3.29	10.74	14.30	14.79	< 2	< 2	< 2
%C	8.51	7.98	7.66	6.83	5.87	6.95	6

9.7.3. German Bight (Germany)

Amount BDE in ng per g organic carbon

compound	Before 1800	Before 1800	Before 1800	Before 1800	Before 1800	Before 1800
BDE28	<20	<20	<20	<20	<20	<10
BDE47	<40	<30	<20	<20	<20	<20
BDE66	<40	<20	<20	<20	<20	<10
BDE71	<20	<20	<20	<20	<20	<10
BDE75	<40	<20	<20	<20	<20	<10
BDE77	<40	<20	<20	<20	<20	<10
BDE85	<20	<10	<10	<10	<10	<10
BDE99	<40	<30	<20	<20	<20	<20
BDE100	<40	<20	<20	<20	<20	<10
BDE119	<20	<20	<20	<20	<20	<10
BDE138	<20	<20	<20	<20	<20	<10
BDE153	<40	<20	<20	<20	<20	<10
BB 153+BDE154	<70	<50	<50	<50	<40	<30
BDE190	<40	<20	<20	<20	<20	<10
BDE209	<130	<70	<90	<70	<70	<50
HBCD	<350	<220	<190	<140	<150	<90
%C	*0.58*	*0.93*	*1.09*	*0.74*	*1.41*	*1.20*

9.7.4. Skagerrak (Denmark)

Amount BDE in ng per g organic carbon

compound	1996±2	1992±2	1984±2	1970±2	1959±3	1928±5
BDE28	< 10	< 15	< 9	< 11	< 9	< 11
BDE47	31	26	19	< 17	9	7
BDE66	< 10	< 15	< 9	< 11	< 9	< 11
BDE71	< 10	< 15	< 9	< 11	< 9	< 11
BDE75	< 10	< 15	< 9	< 11	< 9	< 11
BDE77	< 10	< 15	< 9	< 17	< 9	< 11
BDE85	< 4	5	< 3	< 5	6	< 5
BDE99	15	15	10	< 17	< 9	< 17
BDE100	< 10	< 15	< 9	< 11	< 9	< 11
BDE119	< 10	< 15	< 9	< 11	< 9	< 11
BDE138	< 10	< 15	< 9	< 11	< 9	< 11
BDE153	26	28	< 9	< 17	< 9	< 11
BB 153+BDE154	< 30	< 35	< 25	< 35	< 30	< 35
BDE190	< 10	< 15	< 9	< 11	< 9	< 11
BDE209	64	< 51	< 40	< 56	< 46	< 55
HBCD	< 150	< 150	< 90	< 170	< 90	< 170
%C	**2.0**	**2.0**	**2.3**	**1.8**	**2.2**	**1.8**

9.7.5. Meerfelder Maar (Germany)

Amount BDE in ng per g organic carbon

compound	2000±2	2000±2	2000±2	1995±2	1963±5	1887±20
BDE28	< 2	< 3	< 4	< 6	< 4	< 3
BDE47	< 3	< 4	< 4	< 6	< 5	< 3
BDE66	< 3	< 3	< 4	< 6	< 4	< 3
BDE71	< 2	< 3	< 4	< 6	< 4	< 3
BDE75	< 3	< 3	< 4	< 6	< 4	< 3
BDE77	< 3	< 3	< 4	< 6	< 5	< 3
BDE85	< 2	< 3	< 3	< 4	< 3	< 3
BDE99	< 3	< 3	34	< 6	< 5	< 3
BDE100	< 3	< 3	8	< 6	< 5	< 3
BDE119	< 2	< 3	< 4	< 6	< 4	< 3
BDE138	< 2	< 3	< 4	< 6	< 4	< 3
BDE153	< 4	< 4	9	< 6	< 6	8
BB 153+BDE154	< 6	< 6	< 6	< 11	< 14	< 9
BDE190	< 6	< 6	< 6	< 11	< 7	< 9
BDE209	< 12	1100	190	< 22	< 20	1718
HBCD	88	101	292	< 28	48	35
%C	**16.6**	**15.6**	**16.5**	**18.2**	**14.7**	**3.4**

9.7.6. Birkat Ram (Israel)

Amount BDE in ng per g organic carbon

compound	1999±2	1999±2	1997±2	1972±4	1945±5	1820±20
BDE28	< 8	< 5	< 4	< 3	< 2	< 3
BDE47	< 8	< 10	< 4	< 5	< 3	< 3
BDE66	< 8	< 5	< 4	< 3	< 2	< 3
BDE71	< 8	< 5	< 4	< 3	< 2	< 3
BDE75	< 8	< 5	< 4	< 3	< 2	< 3
BDE77	< 8	< 10	< 4	< 5	< 3	< 3
BDE85	< 4	< 5	< 4	< 3	< 2	< 1
BDE99	< 8	< 10	< 4	< 5	< 3	< 3
BDE100	< 8	< 10	< 4	< 5	< 2	< 3
BDE119	< 8	< 5	< 4	< 3	< 2	< 3
BDE138	< 8	< 5	< 4	< 3	< 2	< 3
BDE153	< 8	< 10	< 8	< 5	< 4	< 4
BB 153+BDE154	< 16	< 19	< 12	< 11	< 6	< 5
BDE190	< 12	< 14	< 12	< 8	< 5	< 5
BDE209	986	348	390	< 16	< 11	< 9
HBCD	211	< 33	152	< 19	< 11	80
%C	**2.6**	**2.1**	**2.6**	**3.7**	**9.3**	**7.6**

Annex 10.1. PBDE concentrations in sediments and biota (recent trend study)

PBDEs in eel from Dutch rivers

ug/kg wet weight

No.:	2000/4223	2000/4187	2000/4181	2000/4193	2000/4199	2000/4211	2000/4175	2000/4169	2000/4229	2000/4241
Location:	Meuse, Eijsden	Haringvliet West	Hollands Diep	Haringvliet East	Nieuwe Merwede	IJssel Lake	Rhine, Lobith	Waal,Tiel	Meuse, Keizersveer	Roer,Vlodrop
BDE28	0.02	0.25	0.35	0.47	0.75	0.11	0.28	0.26	0.2	0.18
BDE47	3.9	7.7	20	20	34	3	29	22	16	20
BDE66	<0.05	<0.05	<0.05	0.32	0.4	<0.04	0.39	0.34	<0.05	0.56
BDE71	<0.05	<0.05	<0.05	<0.05	<0.04	<0.04	<0.05	<0.05	<0.05	<0.05
BDE75	<0.05	<0.05	<0.05	<0.05	<0.05	<0.04	<0.05	<0.05	<0.05	<0.05
BDE77	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
BDE85	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
BDE99	0.84	1.3	1.6	1.4	1.9	0.78	3.4	2.1	0.91	1.505
BDE100	2.1	7	9.6	9	15	1.4	13	13	8.8	10.9
BDE119	<0.05	<0.05	<0.05	<0.05	<0.04	<0.04	<0.05	<0.05	<0.05	<0.05
BDE138	<0.05	<0.05	<0.05	<0.05	<0.04	<0.04	<0.05	<0.05	<0.05	<0.05
BDE153	0.24	2	2.4	3	3.6	0.54	3.8	2.9	2.5	2.7
BB153+BDE154	0.02	1.3	1.6	2	2.8	0.57	2.2	1.7	2.6	0.6
BDE209	<0.2	<0.2	<0.2	<0.2	<0.19	<0.18	<0.19	<0.2	<0.2	<0.19
HBCD	2.7	11	29	13	67	1.9	60	74	10	103

ug/kg fat

No.:	2000/4223	2000/4187	2000/4181	2000/4193	2000/4199	2000/4211	2000/4175	2000/4169	2000/4229	2000/4241
Location:	Meuse, Eijsden	Haringvliet West	Hollands Diep	Haringvliet East	Nieuwe Merwede	IJssel Lake	Rhine, Lobith	Waal,Tiel	Meuse, Keizersveer	Roer,Vlodrop
BDE28	0.23	1.1	2.2	2.6	3.8	0.60	1.8	1.5	1.2	1.4
BDE47	44	35	127	109	172	16	188	124	96	153
BDE66	<0.55	<0.23	<0.32	1.7	2.0	<0.24	2.5	1.9	<0.3	4.2
BDE71	<0.54	<0.23	<0.32	<0.27	<0.23	<0.24	<0.3	<0.27	<0.29	<0.34
BDE75	<0.55	<0.23	<0.32	<0.27	<0.23	<0.24	<0.3	<0.27	<0.3	<0.35
BDE77	<0.57	<0.24	<0.33	<0.28	<0.24	<0.25	<0.31	<0.28	<0.31	<0.36
BDE85	<0.46	<0.19	<0.26	<0.22	<0.19	<0.2	<0.25	<0.23	<0.25	<0.29
BDE99	9.5	5.9	10	7.6	9.6	4.3	22	12	5.5	13
BDE100	24	32	61	49	76	7.7	84	73	53	82
BDE119	<0.54	<0.22	<0.31	<0.27	<0.23	<0.24	<0.29	<0.27	<0.29	<0.34
BDE138	<0.54	<0.22	<0.31	<0.27	<0.23	<0.24	<0.29	<0.27	<0.29	<0.34
BDE153	2.7	9.1	15	16	18	3.0	25	16	15	18
BB153+BDE154	0.23	5.9	10	11	14	3.1	14	10	16	4.5
BDE209	<2.2	<0.93	<1.3	<1.1	<0.93	<0.98	<1.2	<1.1	<1.2	<1.4
HBCD	31	50	185	71	338	10	390	416	60	769

Annex 10.2. PBDE concentrations in sediments and biota(recent trend study) (WP 5)

North sea Cod liver

ug/kg wet weight

no.:	2000/2553	2000/2554
Location:		
BDE28	5.9	4.8
BDE47	98	81
BDE66	4.2	2.4
BDE71	<0.13	<0.12
BDE75	<0.13	<0.12
BDE77	<0.13	<0.13
BDE85	<0.11	<0.10
BDE99	2.7	2.2
BDE100	22	19
BDE119	<0.13	<0.12
BDE138	<0.13	<0.12
BDE153	1.7	0.19
BB153+BDE154	5.4	3.2
BDE209	<0.5	<0.5
HBCD	15	7.4

ug/kg lipid weight

no.:	2000/2553	2000/2554
Fat %:	41.1	44.5
BDE28	14	11
BDE47	238	182
BDE66	10	5.4
BDE71	<0.31	<0.27
BDE75	<0.31	<0.28
BDE77	<0.32	<0.29
BDE85	<0.26	<0.23
BDE99	6.6	4.9
BDE100	54	43
BDE119	<0.31	<0.27
BDE138	<0.31	<0.27
BDE153	4.1	0.43
BB153+BDE154	13	7.2
BDE209	<1.3	<1.1
HBCD	36	17

Annex 11. List of planned scientific paper associated with this study

1. First world-wide interlaboratory study on PBDEs – Chemosphere, accepted in May 2001
2. Method for the determination of PBDEs –Trends Anal. Chem., accepted in June 2001
3. Bioaccumulation of PBDEs – Environ. Sci. Technol. – plan for submission: autumn 2001
4. PBDEs in the surface sediments of the river Tees - Environ. Sci. Technol. – plan for submission: autumn 2001
5. PBDEs in sediment cores - Environ. Sci. Technol. – plan for submission: autumn 2001
6. Temporal trends in PBDE contamination in The Netherlands, UK, and Ireland - Environ. Sci. Technol. – plan for submission: autumn 2001

Titles of nos. 3-6 to be confirmed.

ANNEX 12

Method for the Analysis of Polybrominated Diphenylethers in Sediments and Biota

Jacob de Boer

Netherlands Institute for Fisheries Research (RIVO), P.O. Box 68, IJmuiden, The Netherlands

Colin Allchin, Robin Law

Center for Environment, Fisheries and Aquaculture Science (CEFAS), Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA, UK

Bart Zegers, Jan P. Boon

Netherlands Institute for Sea Research (NIOZ), P.O. Box 59, 1790 AB Den Burg, Texel, The Netherlands

Three institutes worked together on the development and improvement of methods for the analysis of polybrominated diphenylethers (PBDEs) in sediments and biota. The methods developed consist of a Soxhlet, Ultra Turrax*(biota) or shake-flask extraction (sediment) using hexane (or pentane)/acetone solvent mixtures, clean-up by alumina column chromatography or by gel permeation chromatography, further clean-up by silica gel column chromatography and treatment with sulphuric acid. Several alternatives for extraction and clean-up yielded similar results. The final determination is performed by GC/NCI-MS in the selected ion mode with m/z values of both Br isotopes (79 and 81 occurring in a 1:1 ratio). For decaBDE the fragments m/z 486.7 and 488.7 were also scanned. The coefficients of variation obtained with this method are between 10 and 35% for individual congeners, and comply at least with the international state-of-the-art for this type of analysis.

Keywords: Polybrominated diphenylethers; method development; intercomparison studies; gas chromatography; mass spectrometry

1. Introduction

Brominated diphenylethers (PBDEs), which are used as flame retardants, are being determined in a growing number of environmental laboratories world-wide [1]. Consequently, analytical methods for the determination of PBDEs have shown rapid development over the last five years. There are 209 PBDE congeners with identical substitution patterns to the polychlorinated biphenyls (PCBs), and they are numbered in the same manner [2]. However, the number of congeners found in environmental samples is much lower than is the case of PCBs [1] because the three technical PBDE mixtures, known commercially as the Penta-mix, Octa-mix and Deca-mix, each consist

ANNEX 10.3. PBDE concentrations in sediments and biota (recent trend study) (WP 5)

River sediments form the Netherlands and Ireland

ug/kg dry weight

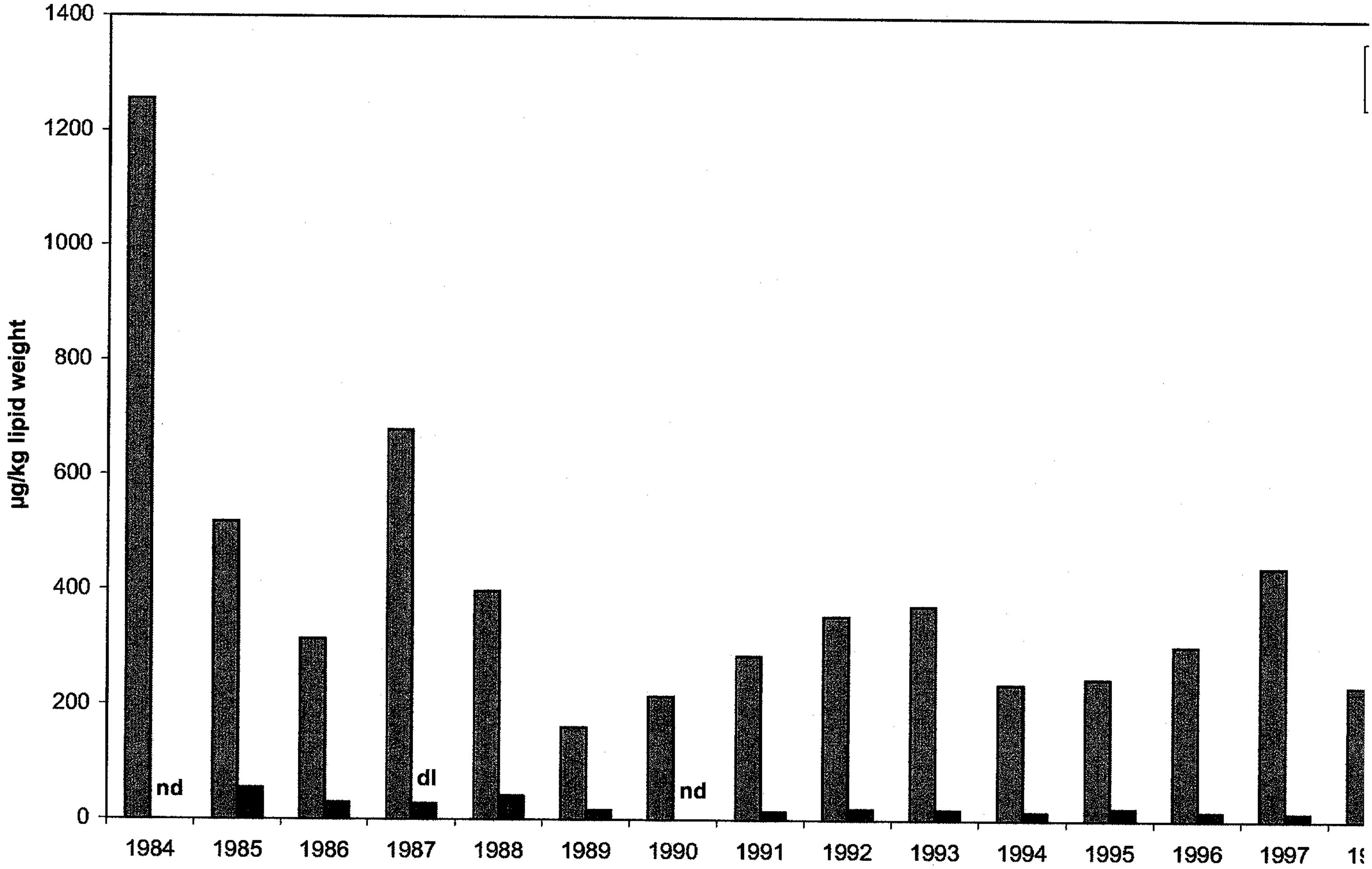
% dry weight:	67.4	51.9	61.5	50.4	50.9	52.5	61.3	58.4		41.0
	Roer, Vlodrop	**Rhine, Lobith**	**Waal, Tiel**	**Hollands Diep**	**Haringvliet West**	**Haringvliet East**	**Nieuwe Merwede**	**Meuse, Eijsden**	**Meuse, Keizersveer**	**Liffey, Dublin**
No.:	2000/35610	2000/35611	2000/35612	2000/35613	2000/35614	2000/35615	2000/35616	2000/35617	2000/35618	2000/38979
% dry weight	67.4	51.9	61.5	50.4	50.9	52.5	61.3	58.4	54.3	41.0
BDE28	<0.22	<0.30	<0.26	<0.28	<0.31	<0.31	1.5	<0.27	<0.28	<0.37
BDE47	1.4	2.6	1.4	3.3	1.1	2.4	9.2	1.0	1.3	2.3
BDE66	<0.22	<0.31	<0.26	<0.29	<0.31	<0.31	<0.26	<0.27	<0.29	<0.37
BDE71	<0.11	<0.15	<0.13	<0.14	<0.16	<0.15	<0.13	<0.13	<0.14	<0.18
BDE75	<0.11	<0.15	<0.13	<0.14	<0.16	<0.16	<0.13	<0.13	<0.14	<0.19
BDE77	<0.23	<0.32	<0.27	<0.30	<0.32	<0.32	<0.27	<0.28	<0.30	<0.39
BDE85	<0.41	<0.57	<0.48	<0.53	<0.58	<0.58	<0.48	<0.50	<0.53	<0.69
BDE99	1.8	2.9	1.5	2.9	0.96	2.3	4.4	0.90	1.5	2.1
BDE100	0.32	0.62	0.46	0.76	0.34	0.62	1.4	0.30	0.40	0.65
BDE119	<0.11	<0.15	<0.13	<0.14	<0.15	<0.15	<0.13	<0.13	<0.14	<0.18
BDE138	<0.22	<0.30	<0.26	<0.28	<0.31	<0.31	<0.25	<0.27	<0.28	<0.37
BDE153	0.51	0.69	0.56	1.1	0.46	0.76	1.5	0.34	0.98	0.62
BB153+BDE154	<0.27	<0.38	<0.32	<0.35	<0.39	<0.38	<1.1	<0.33	<0.35	<0.46
BDE190	<0.44	<0.61	<0.52	<0.57	<0.63	<0.62	<0.51	<0.54	<0.57	<0.75
BDE209	15	86	37	51	9.1	21	50	15	57	467
HBCD	2.6	45	113	38	11	68	440	2.63	6.3	177

ug/kg TOC

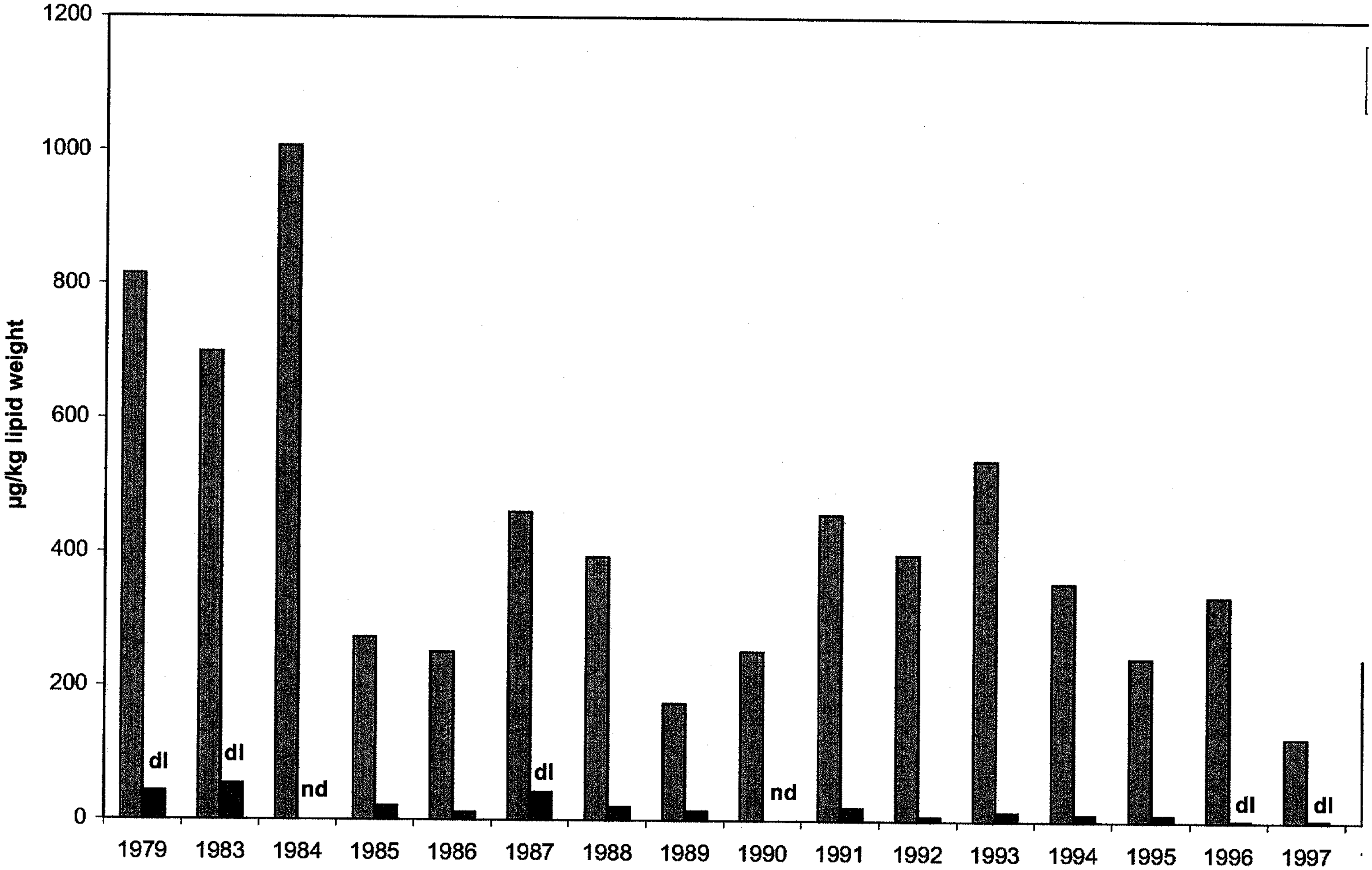
ug/kg TOC

No.:	2000/35610	2000/35611	2000/35612	2000/35613	2000/35614	2000/35615	2000/35616	2000/35617	2000/35618.2	2000/38979
Location:	**Roer, Vlodrop**	**Rhine, Lobith**	**Waal, Tiel**	**Hollands Diep**	**Haringvliet West**	**Haringvliet East**	**Nieuwe Merwede**	**Meuse, Eijsden**	**Meuse, Keizersveer**	**Liffey, Dublin**
% TOC	1.66	3.19	2.99	2.97	2.29	2.35	3.36	3.35	3.10	4.30
BDE28	<8.93	<5.0	<5.3	<4.8	<6.9	<6.9	27	<4.7	<5.1	<3.5
BDE47	58	42	29	55	24	54	167	17	22	22
BDE66	<9.0	<5.0	<5.4	<4.9	<7.0	<7.0	<4.7	<4.7	<5.1	<3.6
BDE71	<4.5	<2.5	<2.7	<2.4	<3.5	<3.4	<2.3	<2.3	<2.5	<1.8
BDE75	<4.5	<2.5	<2.7	<2.4	<3.5	<3.5	<2.3	<2.4	<2.5	<1.8
BDE77	<9.3	<5.2	<5.6	<5.0	<7.2	<7.2	<4.9	<4.9	<5.2	<3.7
BDE85	<17	<9.2	<10	<9.0	<12.9	<12.9	<8.7	<8.7	<9.4	<6.6
BDE99	72	47	30	50	21	51	80	16	26	20
BDE100	13	10	9.4	13	7.6	14	25	5.2	7.1	6.2
BDE119	<4.4	<2.5	<2.6	<2.4	<3.4	<3.4	<2.3	<2.3	<2.5	<1.8
BDE138	<8.9	<4.9	<5.3	<4.8	<6.9	<6.8	<4.6	<4.6	<4.9	<3.5
BDE153	21	11	11	19	10	17	27	6.0	17	5.9
BB153+BDE154	<11	<6.1	<6.6	<6.0	<8.6	<8.6	<20.1	<5.8	<6.2	<4.4
BDE190	<18	<10	<10.8	<9.7	<14	<13.9	<9.4	<9.4	<10	<7.1
BDE209	614	1399	758	859	203	465	913	258	990	4457
HBCD	104	726	2317	647	245	1509	8036	46	111	1685

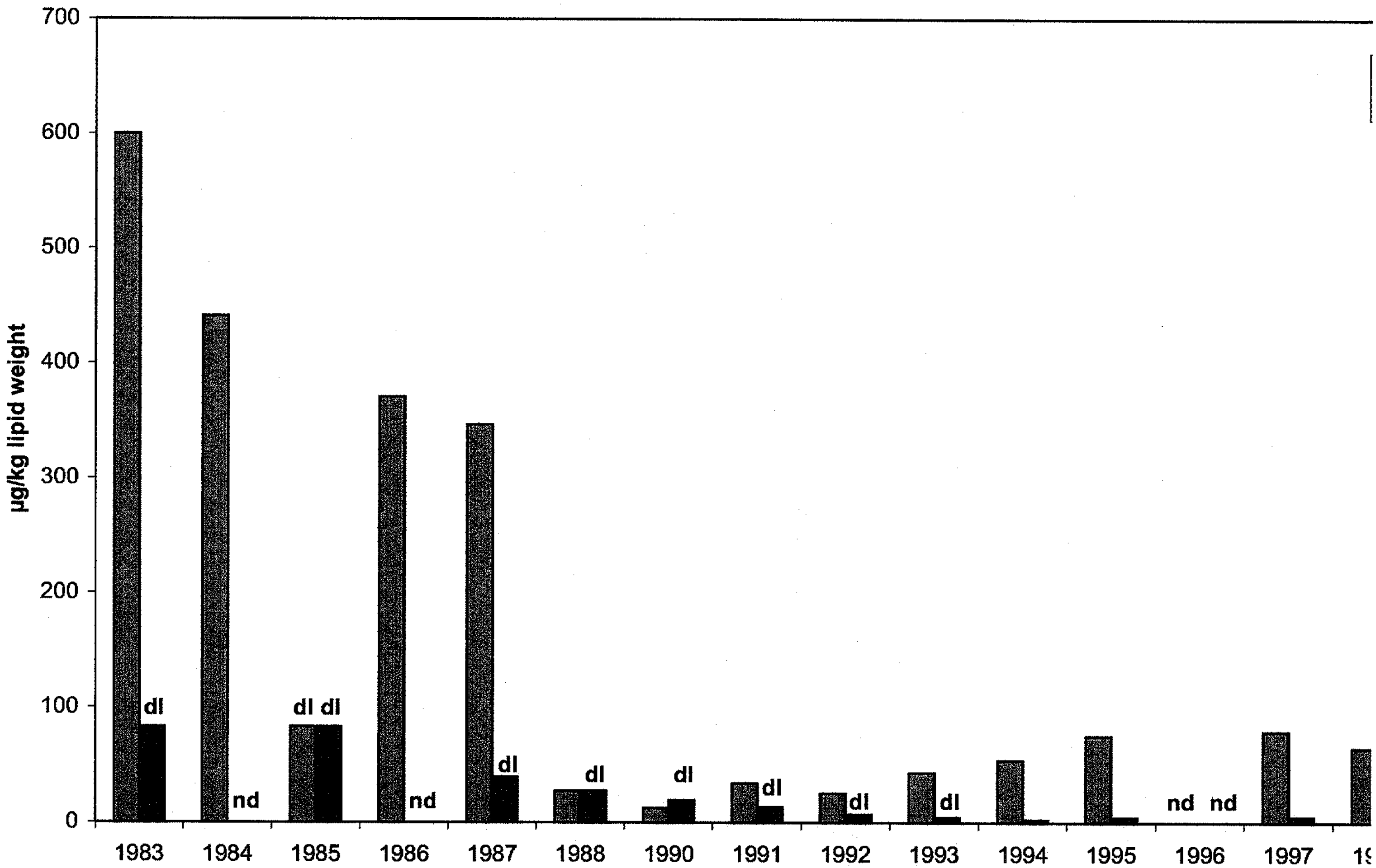
Annex 10.4. Temporal trends of BDE47 and BDE99 in yellow eel from the Rhine, expressed ir lipid weight



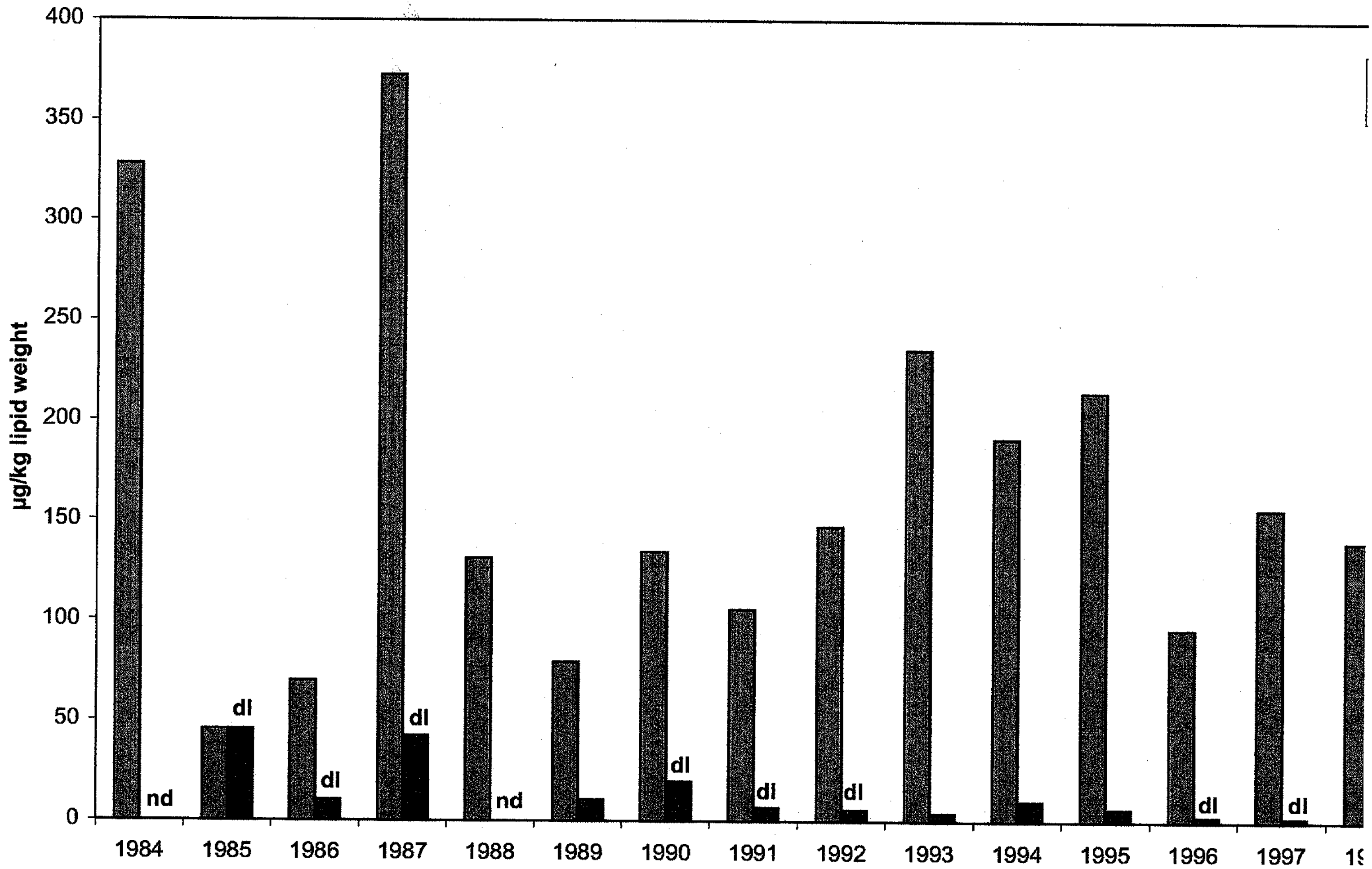
Annex 10.5. Temporal trends of BDE47 and BDE99 in yellow eel from Hollands Diep, expres[...] µg/kg lipid weight

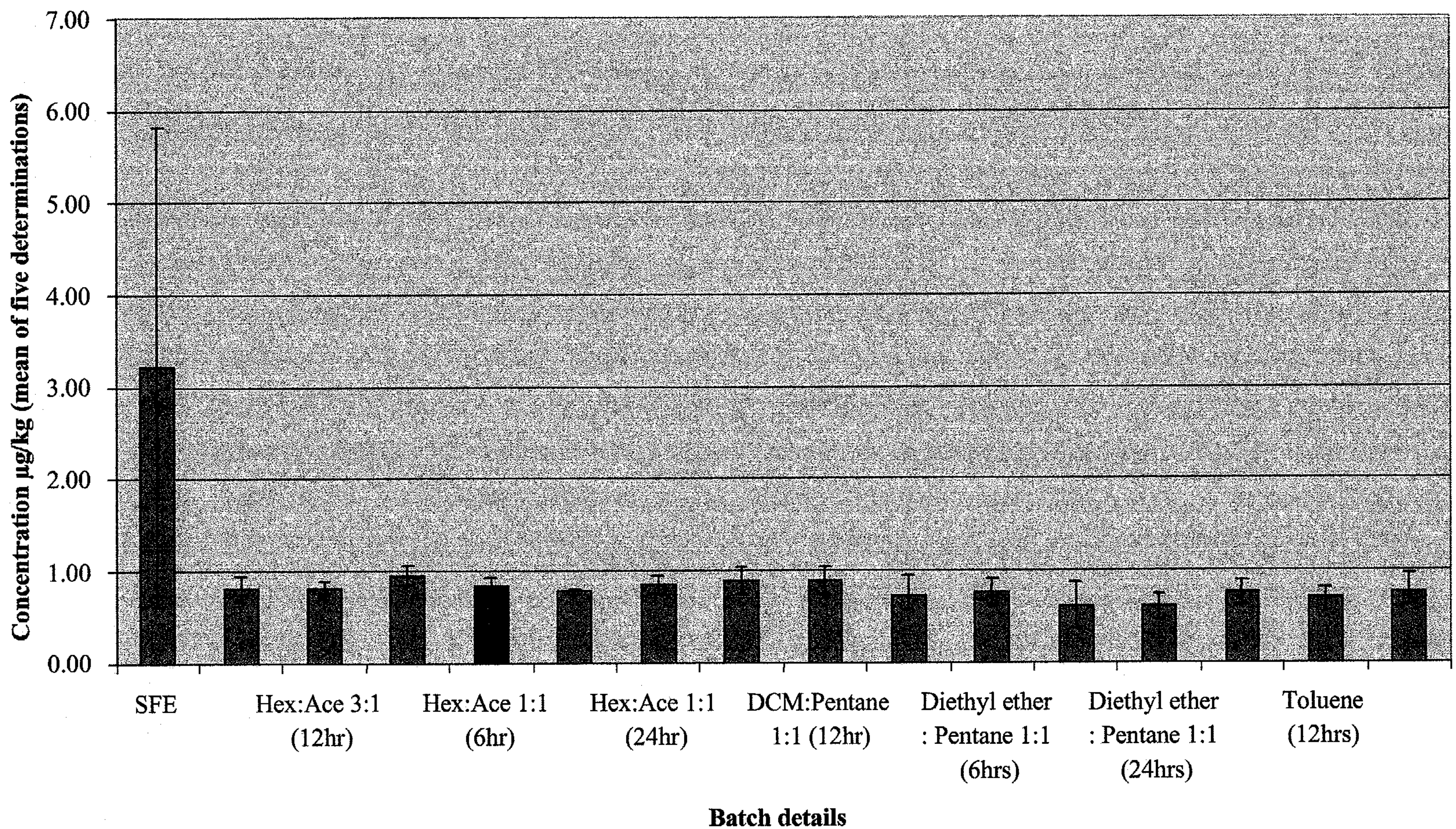


Annex 10.6. Temporal trends of BDE47 and BDE99 in yellow eel from the Meuse (Eijsden), exp in µg/kg lipid weight

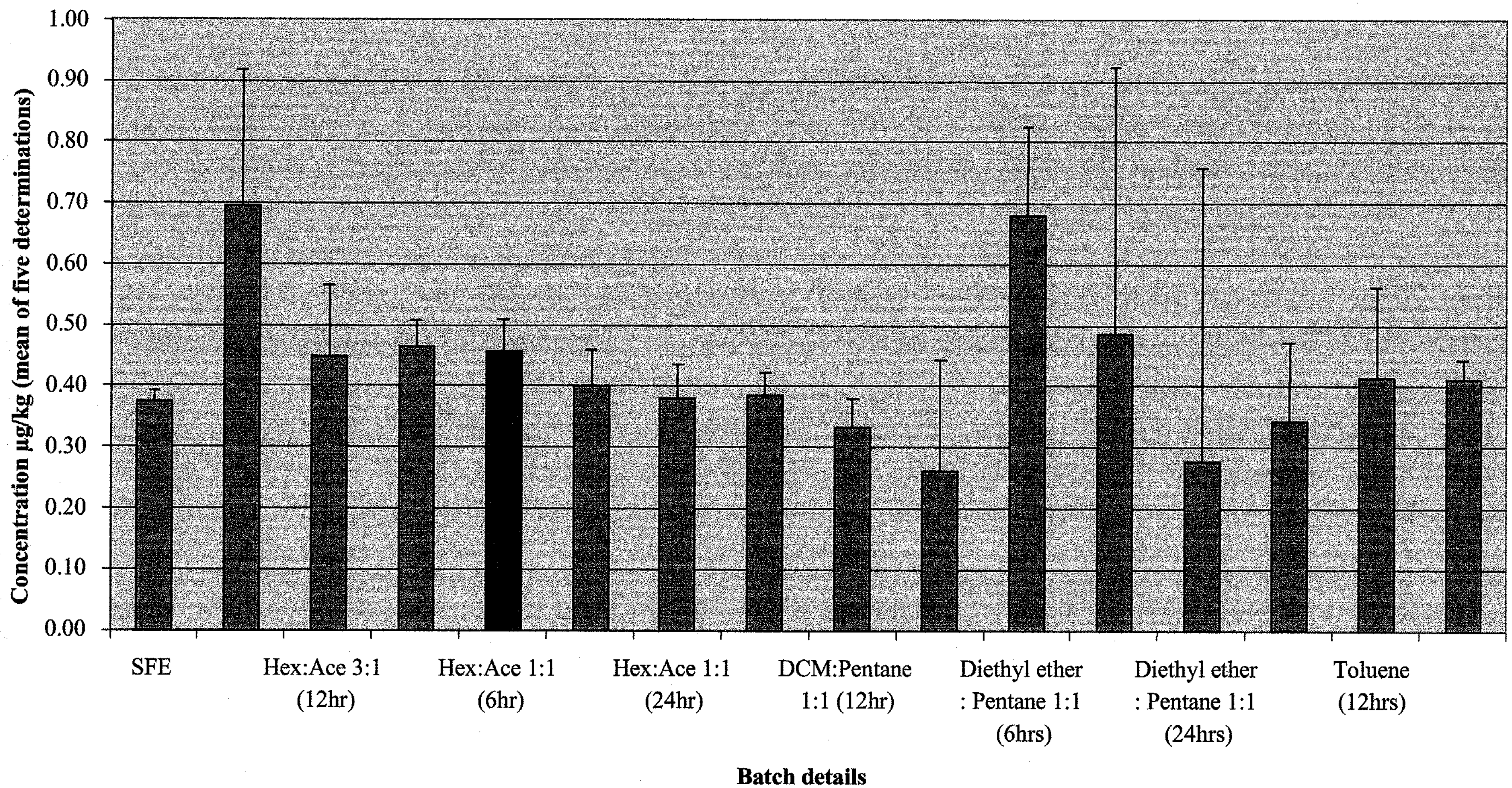


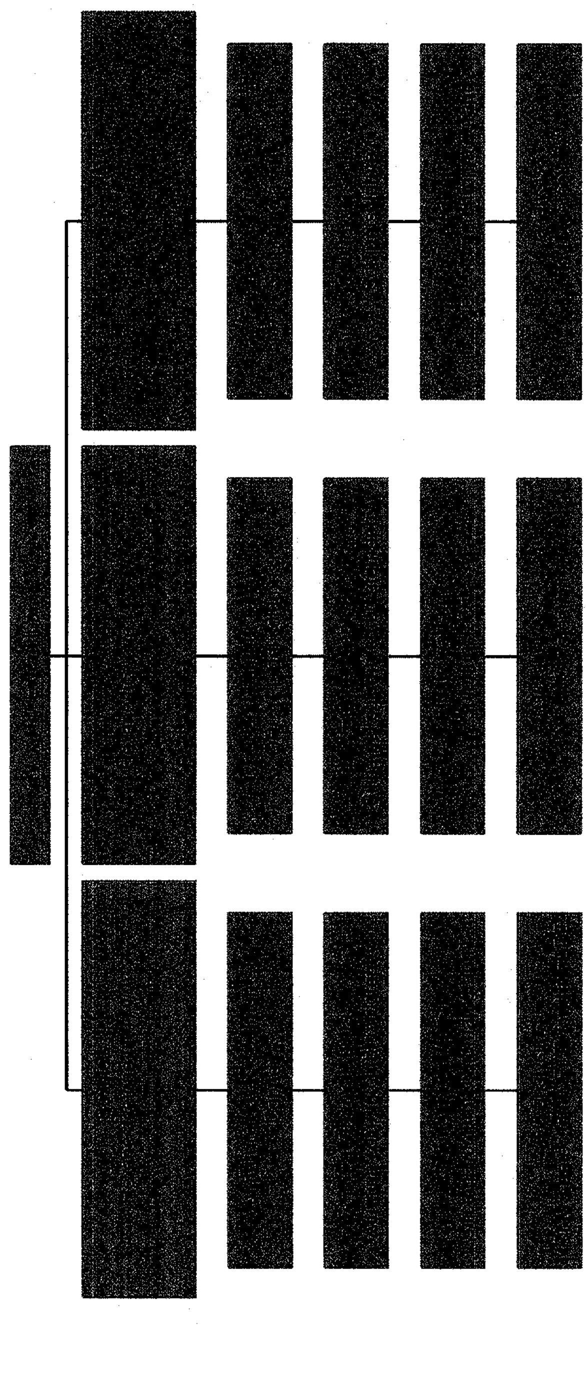
Annex 10.7. Temporal trends of BDE47 and BDE99 in yellow eel from the Meuse (Keizersv
expressed in µg/kg lipid weight





Concentration µg/kg (mean of five determinations)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SFE
Hex:Ace 3:1 (12hr)
Hex:Ace 1:1 (6hr)
Hex:Ace 1:1 (24hr)
DCM:Pentane 1:1 (12hr)
Diethyl ether : Pentane 1:1 (6hrs)
Diethyl ether : Pentane 1:1 (24hrs)
Toluene (12hrs)
Batch details


Concentration µg/kg (mean of five determinations)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
SFE
Hex:Ace 3:1 (12hr)
Hex:Ace 1:1 (6hr)
Hex:Ace 1:1 (24hr)
DCM:Pentane 1:1 (12hr)
Diethyl ether : Pentane 1:1 (6hrs)
Diethyl ether : Pentane 1:1 (24hrs)
Toluene (12hrs)
Batch details



[redacted]

of a limited number of congeners. The Penta-mix consists of 33.7% tetraBDE, 54.6% pentaBDE and 11.7% hexaBDE, whilst the Octa-mix contains 5.5% hexaBDE, 42%heptaBDE, 36% octaBDE, 13.9% nonaBDE and 2.1% decaBDE. DecaBDE contains 3% nonaBDE and 97% decaBDE [3]. The main PBDEs reported from environmental samples are 2,4,2',4'-tetraBDE (BDE47), 2,4,5,2',4'-pentaBDE (BDE99), 2,4,6,2',4'-PeBDE (BDE100), 2,4,5,2',4',5'-hexaBDE (BDE153), 2,4,5,2'4',6'-hexaBDE (BDE154), and 2,3,4,5,6,2',3',4',5',6'-decaBDE (BDE209). 2,3,4,6,2',4',5'-HeptaBDE (BDE183) may also be of importance as this is one of the main compounds in the technical Octa-mix, but as yet only a limited number of data are available for this congener. 2,4,4'-TriBDE (BDE28) is one of the most volatile BDEs (the only tribrominated one determined routinely) and is therefore of interest for modelling studies, but it normally occurs only at low levels in biota and sediments. A small number of other BDE congeners is occasionally reported in environmental samples, but only in low concentrations.

Three laboratories, the Netherlands Institute for Fisheries Research (RIVO), the Netherlands Institute for Sea Research (NIOZ) and the Center for Environment, Fisheries and Aquaculture Science (CEFAS) carried out a number of experiments to develop a reliable method for PBDE analysis and to improve their mutual comparability for these determinations. Details of the methods used and the results of intercomparison studies are given. As comparable results were obtained by mutual different methods, not one 'best' method is presented here, but a framework is presented within which, by a proper selection of various steps, good results can be obtained.

2. Extraction

Polybrominated diphenyl ethers (PBDEs) are persistent, lipophilic, non-polar compounds, and as such are generally amenable to the extraction and clean-up techniques routinely used for other organohalogen compounds such as organochlorine pesticides and polychlorinated biphenyls. An extensive review of these techniques has recently been published [4]. Liquid solid extraction, using Soxhlet apparatus, is widely used as a standard technique and, despite recent advances in techniques such as supercritical fluid extraction, accelerated solvent extraction and microwave assisted solvent extraction, it is still an attractive option for its general robustness and relatively low cost.

Binary solvent systems are most commonly used for their known efficacy over single systems, especially for biota samples which have a low lipid content [5]. The choice of solvents used is largely dictated by purity, polarity, volatility and the cost of disposal. To establish the most suitable system for PBDE extraction from marine sediments a series of fifteen extraction experiments were conducted, comprised of five of the most commonly used solvents and three time periods for the extraction (Table 1).

A bulk sediment sample was collected from the UK NMMP (National Marine Monitoring Programme) Station 375 off the River Humber (53°32'00"N, 00°20'00"E) using a 0.1 m^2 modified Day grab. The sample was air-dried at ambient temperature, thoroughly mixed, and then ground with an agate mortar and pestle before being passed through a 2 mm sieve. Any material retained on the sieve was discarded. Sub-samples of 10 g each were then taken and mixed with approximately 40 g anhydrous sodium sulphate and stored in glass jars prior to extraction. A 1cm layer of anhydrous sodium sulphate was placed into a Soxhlet thimble and the prepared samples transferred to the thimbles, being finally topped with a further 1cm of anhydrous sodium sulphate. The samples were then extracted for the scheduled time and solvent mixture at a rate of 9-10 cycles per hour. Acid washed copper turnings (approximately 30 g) were added to the solvent flask to remove any free sulphur; for these samples this was the only treatment required as the samples had a relatively low sulphur content. If additional treatment were required, the preferred method is that of Jensen *et al.* [6]. Five replicates were made of each time/solvent experiment. To be a true test of extraction efficiency at environmental levels the sediment sample was not spiked with the determinands, as spikes are often more readily recovered than compounds fully integrated with the sample matrix.

The results for BDE47 and BDE209 are presented in the Figures 1 and 2, respectively. With the possible exception of BDE209 the results for the extraction experiments were largely consistent, even at the relatively low concentrations of PBDEs present in the sample. However, the acetone/n-hexane mixtures did produce the lowest coefficients of variation, with the best overall results being obtained with n-hexane/acetone in a 1:1 (v/v) ratio and extraction for 12 h. The results for BDE209 were more variable than those of the tri- to hexa-BDE congeners. This could be a reflection of the known specific problems associated with the measurement step rather than one of extraction efficiency. However, all three institutes noticed that the extraction of BDE209 required specific attention, and, sometimes, longer extraction times. A complete extraction of the other BDEs does in any case not automatically guarantee a complete extraction of BDE209.

Given the known efficacy of *n*-hexane/acetone mixtures in the analysis of other organohalogens and as these solvents fulfil the other requirements discussed earlier, this combination (1:1, v/v) was chosen by CEFAS for the extractions of both sediments and biota.

The RIVO method was based on a 6 – 12 h Soxhlet extraction (extraction time is dependent on the sample size and the volume of the equipment used). A combination of *n*-hexane and acetone (3:1 v/v) was chosen, as a 1:1 mixture yielded too much co-extracted water.

The NIOZ method for biota was based on an Ultra Turrax* extraction. An amount of homogenised animal tissue sample containing about 40 mg of lipid, was weighed. A mixture of three PCBs (CB53, CB112 and CB198) and one bromobiphenyl (the fully brominated BB209, chosen especially with reference to the determination of BDE209) were added as internal standards. Then 20 ml acetone was added and the mixture was run in the Ultra Turrax* (model T25, IKA-Labortechnik, Germany) for 1 min at 13,000 rpm; after addition of 20 ml of pentane, the Ultra Turrax was run again for 1 min, and this was repeated once more after addition of 20 ml double-distilled water. The organic layer was subsequently removed and transferred via a capillary pipette filled with 1 cm of sodium sulphate to a pre-weighed Petri dish for a gravimetrical lipid determination after evaporation of the solvent on a water bath. For the sediments the NIOZ used a shake-flask extraction method., as the short Ultra Turrax extraction method used succesfully for biota was not capable to extract especially BDE209 quantitatively out of the sediment. Sediments were extracted using a shake-flask extraction method which allowed for a much longer contact time between the solvent (acetone) and the sample matrix. About 5 g of sediment was weighed in an Erlenmeyer flask, internal standards (CB112 and BB209), a spatula of sodium sulfite and 15 ml of acetone were added to the sediment and extraction was performed overnight (>12 h) on a Lab-line shaker (Speed 125). Then 15 ml of pentane was added to the contents of the Erlenmeyer flask and shaking with acetone/pentane continued for another 2 h. The contents were transferred in a large centrifuge tube and the Erlenmeyer flask was rinsed with 20 ml bi-distilled water and NaCl was added to the mixture. The tube was centrifuged for 15 min at 2500 rpm. From this point onwards the same clean-up procedure as for the biota was followed.

Most methods reported in the literature are varieties of the methods described above. One essentially different method based on separatory funnel extraction of a biological sample with sodium chloride in phosphoric acid, hexane, acetone and diethylether also ensures a reliable PBDE determination [7,8].

3. Clean-up and fractionation

The scheme in Figure 3 shows the different clean-up methods used by the three laboratories. The methods include i) alumina columns for separation [9,10], followed by silica gel column fractionation (CEFAS), ii) gel permeation chromatography (GPC) using two PL gel columns in series, followed by silica gel column chromatography and a final treatment with sulphuric acid (RIVO), and iii) repeated sulphuric acid treatment (2x) followed by silica gel fractionation (NIOZ). Details are given in Table 2.

In the CEFAS method glass chromatography columns (internal diameter (id): 6 mm) with an appropriate solvent reservoir are dry packed with 3 g of 5% deactivated alumina (Merck, 70-230 mesh, 90 active neutral, no. 1077) and topped with a 1 cm layer of anhydrous sodium sulphate. The sample aliquot is placed on top of the column and eluted with *n*-hexane, and two fractions are collected at 2 ml and 12 ml elution volume. The first fraction is reduced in volume to 1 ml and then subjected to further fractionation using 3 g of 3% deactivated silica (Merck, 70-230 mesh, Kieselgel 60, no. 7734). Fractions are eluted with *n*-hexane and two fractions collected at 7ml and 16ml elution volume. The second silica fraction is combined with the second alumina fraction and the whole reduced in volume to 1 ml. The final two composite fractions are reduced in volume, internal standards (CB53, CB155 and CB198) are added, the solvent exchanged for *iso*-octane (2,2,4-trimethylpentane) and the extracts finally reduced to a final volume of 200 μl to 1 ml depending on the matrix. The first combined fraction contains the chlorobiphenyls, hexachlorobenzene, *p,p*'-DDT, and BDE209. The second fraction contains HCHs, dieldrin, the rest of the DDT group compounds, and the tri- to octa-BDEs.

ANNEX 12

In the RIVO method, the extract is transferred to a GPC system with two PL gel columns in series in which the eluent is dichloromethane. The conditions used are as follows:

Piston pump: Gilson 305 and syringe pump: Gilson 402
Manometric module: Gilson 805 and sampling injector: Gilson 231 XL
Column cooler: Julabo FE-500 (water cooling at 18 °C)
Fraction collector: ISCO Foxy-200
Automated switching valve: Waters ASV 003492
Degassing: helium (99.995%), 0.2 bar
Columns: Polymer Laboratories (PL gel) (crosslinked divinylbenzene)
Pore size: 50 Å, mesh: 10 µm
Injection volume: 0.5 – 2 ml, loop volume: 5 ml
Pressure: 2.5 MPa
Length: 300 mm, id: 25 mm (2 columns in series)
Flow: 10 ml/min (dichloromethane)
Target fraction: 18 – 23 min.

The dichloromethane is removed by evaporation on a rotary-film evaporator and the remaining solution, now in 2 ml *iso*-octane, is eluted over 1.8 g silica gel (Merck Kieselgel 60, 63-200 µm, no. 7754) in a glass column (id 0.6cm). The sample container is flushed with 1.5 ml *iso*-octane which is also transferred to the top of the column. The first fraction (11 ml *iso*-octane) and the second fraction (10 ml 15% (v/v) diethylether in *iso*-octane) are combined and concentrated to 1 ml. One ml of sulphuric acid is added and the extract is mixed with the acid for ca. 10 sec using a Vortex* mixer. The extract is then left overnight to separate from the sulphuric acid. The top layer is then transferred to an amber coloured test tube and mixed on a Vortex mixer with 1 ml distilled water. The top layer is subsequently transferred to a second test tube together with a small quantity of sodium sulphate. Finally, the cleaned extract is transferred to an injection vial.

In the NIOZ method, the lipid (biota) or extract (sediment) is dissolved in pentane and treated twice with sulphuric acid. The pentane is neutralised with a $NaHCO_3$ buffer (25 mM; pH=6), and concentrated to 0.5 ml volume. The residue is transferred to a silica column (2 g silica (Merck, Kieselgel 60, 70-230 mesh, no. 7754) deactivated with 6% water with 1cm sodium sulphate on top) and eluted with pentane The first 20 ml pentane are collected for the determination of PBDEs. After addition of 500 µl of *iso*-octane, the pentane is evaporated to dryness on a water-bath. The residue is weighed and transferred to an injection vial and dissolved in up to 1 ml of *iso*-octane.

Most clean-up methods reported in the literature are varieties of these methods, including multi-layer alumina/silica columns, and other GPC systems. Provided a thorough optimisation has been carried out, most of these methods will not produce essentially different results. The application of several techniques, e.g. alumina, silica and sulphuric acid, or GPC, silica and sulphuric is relevant to ensure a sufficiently clean extract.

4. Final determination

The final determination was carried out by GC coupled with low resolution mass-spectrometric (LRMS) detection, using negative chemical ionisation (NCI) as the ionisation method. Electron capture detection (ECD) was used by CEFAS for the determination of BDE209. Although the selectivity of ECD is obviously less good than that of NCI-MS as this detector also responds to other compounds including organochlorines, the very long retention time of BDE209 allows the use of ECD in this case as separation in this area is less critical. Details of the methods are given in Table 2.
Pulsed splitless injection was used by all three laboratories, although on-column injection may in theory be preferable in order to prevent the possible degradation of thermally-labile higher brominated compounds such as BDE209. However, when using on-column injection, contamination of the first part of the column by involatile material from sample extracts could readily lead to more dramatic effects than observed with splitless injection. The use of a pulse-pressure injection technique for the determination of BDE209 is a good alternative. The residence time in the splitless injector is reduced as much as possible in this way. CEFAS also used a PTV injection technique for the other BDEs, which yielded results which were comparable to those produced within the other laboratories. This technique would not be suitable for BDE209 as a short exposure of the compound to a temperature as high as 450°C would be necessary and some degradation would be expected. The analysis of BDE209 is considerably more difficult than that of most lower brominated flame retardants. BDE209 is subject to degradation by UV light in the laboratory, and at higher temperatures. Therefore, the use of amber glassware is a prerequisite for a reliable analysis of BDE209, and to prevent thermal degradation. Non-polar GC columns were used for the congener-specific determination of BDEs. The use of short GC columns (≤25 m length) is recommended for the determination of this compound. Also, the final temperature of the oven programme used should not be higher than 320 °C for more than a few minutes. Possibly, the use of pressure programming during the GC analysis could further reduce the retention time of BDE209, and in that way reduce the risk for degradation. By separate instrumental analyses of BDE209 on a short column and of all other BDEs using e.g. a 50 m column, degradation of BDE209 is prevented while a good resolution for the other BDEs is ensured. However, intercomparison exercises between the institutes involved showed that a combined analysis of all BDEs on a single 25 m column also resulted in reliable data. That approach obviously offers the advantage of a considerable reduction of GC time.
Mass spectrometric (MS) techniques used in other laboratories utilise both high resolution (HRMS) and low resolution (LRMS) instruments. HRMS is preferred in principle due to its higher selectivity, however it has not been demonstrated that in practice HRMS detection is superior to LRMS [8]. The LRMS techniques used are most often based on NCI, which offers a higher sensitivity than electron impact ionisation (EI). A drawback of the NCI technique is that for most PBDEs only the ions due to bromine can be monitored (m/z 79 and 81). Occasionally, some higher mass fragments

can be used for quantification, such as the m/z 486.7 and 488.7 for BDE209. EI-MS would offer more selectivity and the ability to confirm a compound's identity from its full mass spectrum, but that would be combined with a lower sensitivity. Covaci *et al.* [11] showed that by combining GC/EI-MS with large volume injection and narrow bore columns (0.1 mm id), a sensitivity can be obtained which is comparable to that of NCI-MS, which is combined with the selectivity of EI-MS.

5. Quality assurance

Analytical standards are now available for many BDE congeners, but the selection of appropriate internal standards is still problematic [8]. ^{13}C labelled standards have been made available, but when using NCI-MS these are of little value as only the bromine ions are usually being monitored. Obviously, the analysis of BDE209 will require the use of a different, higher boiling, compound as internal standard than for the other BDEs, which are primarily in the tetra- to hexabrominated region. BB209 was used at the NIOZ laboratory in this study, and resulted in good data. However, until recently this compound was produced commercially in small quantities in France for use as a flame retardant, which means that its possible presence in environmental samples cannot be ruled out. Therefore, the absence of this compound in the samples should be made certain before this compound is used as an internal standard.

Until now, one international interlaboratory study has been organised [8]. The results showed good comparability within the 18 participating laboratories for BDE47, but less good comparability for the other tri-hexa-BDEs and the worst comparability for BDE209. A second interlaboratory study, also including the analysis of hexabromocyclododecane (HBCD) and TBBP-A, is currently in preparation.

Up until now no reference materials certified for BDEs have been available, but now a European research project, entitled Biological Reference Materials for Organic Contaminants (BROC) and due to start in June 2001, is intended to begin the production of two certified reference materials (CRMs) for BDEs, comprising one fish tissue sample and one sediment sample.

6. Interlaboratory tests

All three laboratories participated in the BSEF PBDE interlaboratory study mentioned above [8]. In addition, they undertook two further intercomparison exercises between themselves as part of the method development programme. The first round, conducted before the BSEF interlaboratory study, involved the analysis of a herring sample and a sediment; the second one, conducted after the BSEF study, involved the analysis of a mussel sample and a sediment. In both cases the sediment samples were freeze-dried and the biota samples were wet and sterilised to prevent spoilage. All materials had been used in previous interlaboratory studies for other organic contaminants, and so had been thoroughly tested for homogeneity. The coefficients of variation (CV) obtained for the three laboratories are given in Table 3. Admittedly, statistics are of little value with such a small number of participating laboratories, but the intention of the table is to give an impression of the performance of the three laboratories, and to compare that with the

current "state-of-the-art", which is mainly determined by performance in the BSEF interlaboratory study.
The progress in the analysis of BDE209 is clearly visible. The first exercise showed a CV of 91%, which was reduced to 22% in the final exercise. The analysis of BDE47 is generally better than that for the other BDE congeners. The CVs for the BDE 47 analysis are generally between 10 and 20%, whilst for the other BDE congeners this is generally between 20 and 35%, with occasional higher values. The BDE100 analysis clearly lies within the lower part of this range, whilst the BDE99 analysis lies towards the upper end of the range and is clearly one of the more difficult analyses, presumably due to problems with co-elution in that area of the chromatogram. The performance of the three laboratories for the BDE209 analysis is clearly better than the state-of-the-art. One of the conclusions of the BSEF interlaboratory study was that laboratories were not able to produce comparable results for BDE209 [8]. The performance of these three laboratories for the other BDE congeners is comparable to or slightly better than the state-of-the-art e.g. for BDE100. Results obtained for the final mussel sample (3.1) in Table 3 shows that the performance of three laboratories is still very good for the BDE47 and BDE100, although the absolute concentrations are extremely low (0.4 and 0.08 ng/g, respectively).

7. Future developments

One series of extraction experiments was carried out with supercritical fluid extraction (SFE). The SFE conditions were similar to those reported by Bøwadt and Johansson [12]. These are summarised as follows: Step I - a static extraction for 20 min with pure, SFE grade CO_2 at a density of 0.75 g ml^{-1} (218 bar) with a chamber temperature of 60 °C and a flow rate of 1 ml min^{-1}. This was followed by Step II – a dynamic extraction for 40 min with pure CO_2 + 5 % methanol (HPLC grade, as above) with the same density, pressure, chamber temperature and flow rate as Step II. The nozzle temperature was kept constant and at 45 °C whilst the trap temperatures during Steps I and II were 20 and 65 °C, respectively. The trap packing was 1 ml of octadecyl silica gel. Following Step II, the trap was eluted sequentially with 2 x 1 ml *n*-hexane. The two extracts were combined and reduced to 1 ml for column chromatographic clean up. The recovery of BDE209 was not better with SFE than with the various Soxhlet extractions (Figure 2). The mean recovery of BDE47 was much better than for all Soxhlet extractions (Figure 1). However, the coefficient of variation of this mean was so large that the large difference in recovery efficiency observed was still not statistically significant. More experiments would be required prior to drawing firm conclusions on the utility of SFE for the analysis of PBDEs. Also, one series of experiment was carried out with the same samples with microwave assisted solvent extraction (MASE) with a MARS-X microwave (CEM Microwave Technology Ltd., Buckingham, UK). The replicates were subjected to MASE in a closed vessel containing 30 ml *n*-hexane-acetone (1:1, v/v; HPLC grade, Rathburns Chemical Co., Walkerburn, Scotland). One g of copper powder (>99.9 %, Aldrich, Dorset, U.K.) was mixed with the sediment sample to remove elemental sulphur during extraction. The extraction time and temperature were 15 min and 115°C, respectively. The microwave power was 600 W and 100%. Concentrations

of the BDEs 47 and 99 were similar to those recovered from the same sediment which had been Soxhlet extracted for 6 h using 120 ml of a *n*-hexane:acetone mixture. BDE209 was not included in this study.
As regards the final determination, a good separation can be obtained for most congeners using 50 m columns, but two critical pairs, BDE154 and BB153, and BDE153 and tetrabromobisphenol-A (TBBP-A) co-elute in many cases. MS normally offers enough selectivity for the identification and quantification of TBBP-A and BDE153 even when they do co-elute. Comprehensive multi-dimensional gas chromatography (MDGC or GCxGC) now offers a possibility for the separation of BDE154 and BB153 in a single-column GC analysis [13]. This GCxGC technique is now developing towards a mature and robust technique which is very helpful in the analysis of many complex mixtures of environmental contaminants [14-16].

8. Conclusions

The results of the interlaboratory studies show that although the methods used by the three institutes were different in some aspects, comparable results could be produced. This shows that, as for other organic contaminants, there are various possibilities that will result in a sound analytical approach. However, there are certainly also other possibilities which undoubtedly lead to unreliable results, and which should be avoided. The methodology proposed here, including alternatives for some parts of the procedure, leads to reliable PBDE data with an uncertainty that at least complies with the current state-of-the-art, and in some cases improves it. Further improvements may also be possible in the near future. The method proposed consists of a Soxhlet extraction with *n*-hexane/acetone (1:1 or 3:1, v/v) (for biota and sediments), an Ultra Turrax* extraction with acetone/pentane/water (1:1:1, v/v/v) (for biota only) or a shake-flask extration with acetone/pentane (1:1, v/v) for sediments, followed by a fat/organic matter separation by alumina column chromatography or GPC, using two PL gel columns in series. The clean-up is finalised by silica gel column chromatography, and a treatment with sulphuric acid. The GC analysis should preferably be made after a pressure-pulse splitless injection on a 50 m x 0.25 (or 0.20) mm column for the majority of the PBDE congeners, with a second run on a 15m x 0.25mm column for the determination of BDE209 alone. An alternative approach is the use of a single GC run on a 25 m x 0.25 mm column. Possible degradation of BDE209 due to exposure to high temperature for a long period of time should always be thoroughly checked. Amber glassware is recommended for use during the extraction and clean-up for all BDE congeners, and is essential for the analysis of BDE209. The coefficients of variation obtained with this method are between 10 and 20% for BDE 47, 20-25% for BDE 209, 10-30% for BDE100, and 20-35% for the other BDEs.

9. Acknowledgement

This study was funded by the Bromine Science and Environmental Forum (BSEF), Brussels, Belgium. The authors thank Steven Morris and Moira Bennett (CEFAS),

ANNEX 12

Wilma Lewis (NIOZ), and Judith van Hesselingen, Peter Wester and Sicco Brandsma (RIVO) for skilfull assistance.

References

[1] J. de Boer, K. de Boer, J.P. Boon, Polybrominated biphenyls and diphenylethers, in: J. Paasivirta (Editor), Handbook of Environmental Chemistry, New Types of Persistent Halogenated Compounds Vol. 3, part K., 61., Springer Verlag, Heidelberg, Germany, 2000.
[2] K. Ballschmiter, Bacher, R., Mennel, A., Fischer, R., Riehle, U., Swerev, M., J. High Resolut. Chromatogr. 15 (1992) 260.
[3] M. Spiegelstein, Brominated compounds, addressing the gap in scientific knowledge, BSEF Workshop, IJmuiden, The Netherlands, 25-27 June 2000.
[4] D.E. Wells, Ph. Hess, Separation, clean-up and recoveries of persistent trace organics contaminants from soils, sediment and biological matrices, pg 73-113 in: D. Barcelo (Editor) Sample Handling and Trace Analysis of Pollutants: Techniques, Applications and Quality Assurance, p. 73-113, Elsevier, Amsterdam, The Netherlands, 2000.
[5] J. de Boer, Chemosphere 17 (1988) 1803.
[6] S. Jensen, L.Renberg, L. Reutergardh, Anal. Chem. 49 (1977) 316
[7] B. Jansson, R. Andersson, L. Asplund, Å. Bergman, K. Litzén, K. Nylund, L. Reutergårdh, U. Sellström, U.Britt-Uvemo, C. Wahlberg, U. Wideqvist, Fresenius J. Anal. Chem. 340 (1993), 439.
[8] J. de Boer, W.P. Cofino, BSEF PBDE interlaboratory study. Chemosphere, in press.
[9] A.V. Holden, K. Marsden, J. Chromatogr. 44 (1969) 481
[10] D.E.Wells, A.A. Cowan, A.E.G. Christie, J.Chromatogr. 328 (1985) 372
[11] A. Covaci, J. de Boer, J.J. Ryan, P. Schepens, Determination of PBDEs (and PCBs) in human adipose tissue by large volume injection narrow bore-high resolution chromatography-electron ionisation low resolution mass spectrometry, Proceedings BFR 2001, Stockholm University, Stockholm, Sweden, 2001.
[12] S. Bøwadt, B. Johansson, Anal. Chem., 66 (1994) 667.
[13] J. de Boer, P. Korytar, Analysis of brominated flame retardants – methodological issues, Proceedings BFR 2001, Stockholm University, Stockholm, Sweden, 2001.
[14] W. Bertsch, J. High Resolut. Chromatogr. 23 (2000) 167.
[15] H.-J. de Geus, A. Schelvis, J. de Boer, U.A.Th. Brinkman, J. High Resolut. Chromatogr. 23 (2000) 189.
[16] Ph. J. Marriott, R.M. Kinghorn, J. Chromatogr. A 866 (2000) 203.

ANNEX 12

Table 1. Extraction solvent combinations used and extraction times tested.

Extraction times	Solvents
6 hours	*n*-Hexane:acetone 3:1, v/v
12 hours	*n*-Hexane:acetone 1:1, v/v
24 hours	Dichloromethane:*n*-pentane 1:1, v/v
	Diethyl ether:*n*-pentane 1:1, v/v
	Toluene

ANNEX 12

Table 2. Analytical methods used in this study.

	RIVO	NIOZ	CEFAS
Extraction (biota)	Soxhlet	Ultra Turrax*	Soxhlet
Solvents (biota)	Hexane/acetone (3:1, v/v)	Acetone/pentane/water (1:1:1, v/v/v)	Hexane/acetone (1:1, v/v)
Extraction (sediment)	Soxhlet	Shaking	Soxhlet
Solvents (sediment)	Hexane/acetone (3:1, v/v)	Acetone/pentane (1:1, v/v)	Hexane/acetone (1:1, v/v)
Sulphur removal	GPC	Na_2SO_3, H_2SO_4	copper
Fat separation	GPC	H_2SO_4	GPC
Further clean-up	Silica and H_2SO_4	Silica	Silica
Internal standard	CB112	CB 112, BB209	CB198
GC column 1	CP Sil 8	CP Sil 8	DB-5
Dimensions	50m-0.21mm-0.25µm	25m-025mm-0.25 µm	50m-0.25mm-0.25µm
Injector temp. (°C)	275	275	50
Max. oven temp.(°C)	315	320	275
Injection technique	Pulsed splitless	Pulsed splitless	PTV*
GC col.2 (BDE209)	DB-5	-	HP-1
Dimensions	15m-0.25mm-0.25µm		15m-0.25mm-0.1µm
Injector temp. (°C)	275		70*
Max. oven temp.(°C)	300		295
Detection technique	NCI-MS	NCI-MS	ECD for BDE209 NCI-MS for other BDE co
Injection technique	Pulsed splitless		Pulsed splitless
Quantification	Area	Height	Height
Scanned ions	79, 81; HBCD: 158, 160; BDE209: 486.7, 488.7	79, 81; BDE209: 486.7	79, 81

* PTV conditions: Initial temp.: 70 °C, initial time: 0.3 min, ramp at 720 °C/min to 450 °C, final time: 5 min, vent time: 0.2 min, vent flow:
100 ml/min, purge flow: 500 ml/min, purge time: 3 min.

ANNEX 12

Table 3. Coefficients of variation from intercomparisons (n=3).

Material	BDE concentrations (ng/g)	BDE28	BDE47	BDE99	BDE100	BDE153	BDE154	BDE209
1.1 Herring	< 0.5 – 10	2.6	8.9	15	27	14	9.2	-
1.2 Sediment	< 0.1 – 5	-	8.6	36	30	41	26	91
2.1 Eel	< 0.5 – 10	8.3*	7.5	48	21	87	12	-
2.2 Mussels	< 0.05 – 0.5	-	24	20	28*	33	20	-
2.3 Cormorant liver	< 0.5 – 50	-	28	55	15	41	23	-
2.4 Porpoise liver	< 0.5 – 130	23	14	31	2.4*	29	33	-
2.5 Porpoise oil	< 0.5 – 630	30	22	39	65	40	14	-
2.6 Sediment	< 0.05 – 3	34	11	36	12	33	36	26*
2.7 Sediment	< 0.05 – 65	18	12	32	11	22	18	15*
3.1 Mussels	< 0.1 – 0.5	47*	17	46	11	39*	-	-
3.2 Sediment	< 0.1 – 45	22	32	37	30	78	49*	22

*n=2; -: not detectable.

ANNEX 12

Text Figures:

Figure 1: Results of extraction experiments for BDE 47.

Figure 2: Results of extraction experiments for BDE 209.

Figure 3: Overview of analytical methods used in the three laboratories.